Agua(cate)
Resource Scarcity, Systems Resilience, and Avocado Agriculture in San Diego County, California

by

Riley J. Balikian

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science
(Environment and Resources)

at the
University of Wisconsin-Madison

June 2016
Agua(cate): Resource Scarcity, Systems Resilience, and Avocado Agriculture in San Diego County

By: Riley Balikian

Under the direction of Ken Genskow, PhD.

Thesis Committee:
William Bland, PhD.
University of Wisconsin-Madison, Department of Soil Science, affiliate of the Gaylord Nelson Institute for Environmental Studies

Revel Sims, PhD.
University of Wisconsin-Madison, Department of Urban and Regional Planning

Abstract:
Farmland loss decreases the economic and ecological diversity of landscapes along the urban fringe. In the United States, farmland loss has remained steady at over a million acres per year since 1960, about 2.5% of farmland every decade. Much of the land being lost is being converted to urban uses and especially threatens the production of high-value or specialty crops. San Diego County is considered an urban county, but has more farms than any other county in the United States, with over 5,700 operations. San Diego County is losing farmland at the extremely high rate of 8.4% every year, much of that land considered “prime.” This land is also among the most productive farmland in the United States in terms of crop production value, and is some of the last remaining land in agriculture in southern California. This thesis takes a transdisciplinary, systems approach to identify and describe the factors driving system change in the agricultural production sector in San Diego County, especially among avocado growers. Stakeholder interviews and a survey of avocado growers were supplemented by secondary data to examine the issues at stake. Water-resource related issues—especially the cost of water—were identified as the most important issues facing avocado growers, but socioeconomic drivers and environmental drivers were identified as well, including land resources, drought conditions, tax laws, zoning ordinances, institutional and contractual arrangements, free trade, and commodity markets.
Acknowledgments and Dedication

This thesis is the compilation of the work of many hands. The author would like to acknowledge a few of those directly involved in making this happen. First, I would like to thank staff and representatives from the San Diego County Farm Bureau, the University of California Cooperative Extension, the several water districts in San Diego County, and those involved in the avocado industry who all gave their time and input into making this thesis. This thesis would not have been possible without them.

I would like to thank friends, coworkers, thesis committee members, and family members who supported me during this time, who worked around my absence when I was not present, and who through conversations and discussion helped formulate thoughts, frameworks, and a general understanding of the situation in the county, and how best to express that in words for this thesis.

I would also like to thank the growers in San Diego County who completed the survey, some of whom spent over an hour longer answering open-ended questions than the minimum asked of them. Their input was extremely valuable, and their struggles with respect to the changing socioeconomic and environmental landscapes in the county demonstrate the future for hardworking farmers on the urban fringe in our country and the world. This work is dedicated to them and their families.
# Table of Contents

**Abstract**  
1

**Acknowledgments and Dedication**  
ii

**Table of Contents**  
iii

**List of Tables**  
v

**List of Charts and Figures**  
vi

**List of Abbreviations**  
vii

## Chapter 1

**Background and Methods**  
1

- Background and Introduction  
1
- Underlying Conceptual Bases  
8
- Methods  
15
- Research Limitations  
18
- Orientation to Remainder of Document  
19

## Chapter 2

**San Diego Agriculture: History, Context, and Institutions**  
21

- The Legacy of History  
22
- Geography and Social Context  
26
- Political and Economic Context  
27
- Water Resources Institutions and Policy  
36
- Agricultural Institutions and Policies  
45
- Conclusion  
54

## Chapter 3

**The Avocado in San Diego: Biophysical & Environmental Considerations**  
55

- Overview of Agriculture in San Diego County  
55
- Avocado Ecophysiology  
60
- Biophysical Context of San Diego County  
63
- Conclusion  
70

## Chapter 4

**The Problem Context: Local, Regional, and National Trends**  
72

- Introduction  
72
- Land Values and Land Use  
77
- Water  
85
- Avocado Market  
95
- Policy and Economic  
101
- Conclusion  
102

## Chapter 5

**Review and Synthesis**  
104

- Overview  
104
List of Tables

Table 1a. Annual farmland acres lost, 2002-2012 3
Table 2a. Special districts in the United States and California 34
Table 2b. Original allocation of Colorado River water 43
Table 3a. San Diego County agricultural overview 57
Table 3b. Varieties of Avocados Grown in San Diego County, 1975 59
Table 3c. Estimated water requirements for an example mature avocado orchard near Escondido, CA, 1999-2015 67
Table 3d. Average annual rainfall near Escondido, CA, 1999-2015 67
Table 4a. Demographics of survey respondents 74
Table 4b. Important themes in survey responses 74
Table 4c. Survey results: policies helping and hurting agriculture in San Diego County 76
Table 4d. Land use change by category, 1990-2010 78
Table 4e. Land enrolled in the CLCA, 1991-2013 84
Table 4f. Water Rates in 2005 and 2016 93
Table 5a. Behavior-based indicators of resilience for agroecosystems 106
Table 5b. Subsystem components in the San Diego County agricultural production system 107
List of Charts and Figures:

Figure 1a. Loss of land in orchards and vineyards in San Diego County, 2005-2015 5
Figure 1b. Food Systems: drivers and feedbacks 10
Figure 1c. The San Diego County water resources problemshed 15
Figure 2a. Acres in avocados in San Diego County, 1955-1981 30
Figure 2b. Growth of special districts in the United States 34
Figure 2c. San Diego Regional Water Quality Control Board 41
Figure 3a. Distribution of farms by size: United States, California, and San Diego County, 2012 58
Figure 3b. Average monthly maximum and minimum temperature at Escondido CIMIS Weather Station, 1999-2015 63
Figure 3c. Lands in orchards and vineyards in San Diego County 65
Figure 3d. Average monthly ETo (inches) at Torrey Pines and Escondido CIMIS Stations, 1999-2015 69
Figure 4a. Average land value in ten largest US cities, 1984-2014 79
Figure 4b. Change in average land value in ten largest U.S. cities, 1984-2014 80
Figure 4c. Acres enrolled in the Williamson Act program in California and San Diego County, 1965-2013 81
Figure 4d. Acres enrolled in Williamson Act and land in orchards and vineyards in San Diego County 82
Figure 4e. Acres enrolled in the Williamson Act and land values in San Diego MSA, 1991-1992 83
Figure 4f. Surface water level of Lake Mead (feet above sea level) 89
Figure 4g. Palmer Hydrologic Index: South Coast California Climate Division, 1895-2015 90
Figure 4h. Average monthly precipitation near Escondido, CA: water years 1980-2014 91
Figure 4i. Water Rates in three representative water districts in San Diego County (adjusted for inflation to 2016 dollars) 93
Figure 4j. Hass avocado sales in the United States, 2004-2014 97
Figure 4k. Volume of Hass avocados for U.S. markets (pounds), 2005-2015 98
Figure 4l. Average price per avocado in the United States ($), 2004-2014 99
Figure 4m. Volume of Hass avocados produced (pounds) in California and San Diego County, 2005-2014 99
Figure 4n. Volume of avocados produced (tons) in San Diego County, 1955-2014 101
Figure 6a. Acreage in avocados and vineyards in San Diego County, 2004-2014 124
Figure 6b. Potential policy influences on food and agriculture systems 126
Figure 6c. Proportion of SDCWA Water, by source, 1991-2015 130
Figure 6d. Proportion of water used in SDCWA, by category, 1991-2015 130
# List of Abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF</td>
<td>Acre-feet</td>
</tr>
<tr>
<td>BLS</td>
<td>Bureau of Labor Statistics</td>
</tr>
<tr>
<td>CDC</td>
<td>California Department of Conservation</td>
</tr>
<tr>
<td>CIMIS</td>
<td>California Irrigation Management Information System</td>
</tr>
<tr>
<td>CLCA</td>
<td>California Land Conservation Act (Also called the Williamson Act)</td>
</tr>
<tr>
<td>CRC</td>
<td>Colorado River Compact</td>
</tr>
<tr>
<td>DAWM</td>
<td>San Diego County Department of Agriculture, Weights, and Measures</td>
</tr>
<tr>
<td>ET</td>
<td>Evapotranspiration</td>
</tr>
<tr>
<td>ET₀</td>
<td>Reference Crop Evapotranspiration</td>
</tr>
<tr>
<td>FMMP</td>
<td>Farmland Mapping and Monitoring Program</td>
</tr>
<tr>
<td>HAB</td>
<td>Hass Avocado Board</td>
</tr>
<tr>
<td>HAPRI</td>
<td>Hass Avocado Promotion, Research, and Information Act of 2000</td>
</tr>
<tr>
<td>IRWMP</td>
<td>Integrated Regional Water Management Plan</td>
</tr>
<tr>
<td>JLWC</td>
<td>Junipero Land and Water Company</td>
</tr>
<tr>
<td>K₀</td>
<td>Crop constant</td>
</tr>
<tr>
<td>LQ</td>
<td>Location Quotient</td>
</tr>
<tr>
<td>MSA</td>
<td>Metropolitan Statistical Area</td>
</tr>
<tr>
<td>MWD</td>
<td>Metropolitan Water District of Southern California</td>
</tr>
<tr>
<td>MWD*</td>
<td>[Water District] Municipal Water District (*when paired with water district name)</td>
</tr>
<tr>
<td>NAFTA</td>
<td>North American Free Trade Agreement</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NRCS</td>
<td>National Resource Conservation Service</td>
</tr>
<tr>
<td>PHI</td>
<td>Palmer Hydrologic Index</td>
</tr>
<tr>
<td>PUD</td>
<td>Public Utilities District</td>
</tr>
<tr>
<td>SDCFB</td>
<td>San Diego County Farm Bureau</td>
</tr>
<tr>
<td>SDCVA</td>
<td>San Diego County Vintners Association</td>
</tr>
<tr>
<td>SDCWA</td>
<td>San Diego County Water Authority</td>
</tr>
<tr>
<td>SDFC</td>
<td>San Diego Flume Company</td>
</tr>
<tr>
<td>SDRWQCB</td>
<td>San Diego Regional Water Quality Control Board</td>
</tr>
<tr>
<td>SES</td>
<td>Social-Ecological Systems</td>
</tr>
<tr>
<td>SWRCB</td>
<td>State Water Control Resources Control Board (California)</td>
</tr>
<tr>
<td>UCCE</td>
<td>University of California Cooperative Extension</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
<tr>
<td>WY</td>
<td>Water year (the water year in California runs from October 1—September 30)</td>
</tr>
</tbody>
</table>
Chapter 1
Background and Methods

“San Diego needs to decide if they want to have avocado farms (or perhaps farms in general). If they do, they need to provide economic relief for the price of water...This whole situation is a man-made economic disaster that doesn't get lots of press interest, but which is similar to a natural disaster in terms of its impact on the poor who work the farms and orchards.”

-Avocado Grower, San Diego County

Background and Introduction

Introduction

The preservation of agricultural land in the rural areas of the United States is dependent on the resilience and viability of rural economies, including land markets and resource availability. Some have identified the loss of agricultural land at the urban fringe in the United States as one of the most significant planning and environmental issues facing metropolitan areas today (Clark, 2009; Heimlich & Anderson, 2012). Urban land conversion often has negative implications in terms of environmental and ecological services, direct and indirect costs, diversity of land uses, and production of crops, especially high-value and specialty crops (Heimlich & Anderson, 2012).

The most recent Census of Agriculture\(^1\) by the United States Department of Agriculture (USDA) in 2012 estimates that an average of about 1.5 million acres of farmland were permanently lost each year in the United States for the past five years; the National

\(^1\) The Census of Agriculture has been undertaken by the USDA every ten years since 1840 and every four to five years since 1920 to provide a detailed picture of U.S. farms and ranches in the United States.
Resource Conservation Service (NRCS) estimates that over 220,000 of those annual acres lost are considered “prime farmland” (American Farmland Trust, 2012). The causes of farmland loss vary from place to place, but the greatest reason for land conversion is urban development, which leads to about 600,000 of acres of farmland per year being converted to other uses (American Farmland Trust, 2012). This is especially true in California, which has both the United States’ largest urban population and the largest agriculture sector. (USDA Economic Research Service, 2014; U.S. Census Bureau, 2014).

**Context**

Most of the agricultural land in California is located in a region known as the San Joaquin Valley. Eight of the top ten counties for crop production value in California are located in there, and media and policy often concentrate only on this region when they address agriculture in California. However, because of the San Joaquin Valley’s relative isolation from large metropolitan areas, the risk that a given acre in the San Joaquin Valley will be converted to an urban land use is relatively small.

The coast, foothills and mountain valleys of southern California, on the other hand, are home to three of the United States’ largest metropolitan areas (Los Angeles-Long Beach-Anaheim; Riverside-San Bernardino-Ontario, and San Diego-Carlsbad). These large urban agglomerations have been eating away at the unique agricultural land there for decades.

---

2 California produces about 31% of the U.S. citrus production, 21% of milk production, 25% of the floriculture production, 87% of avocado production, 22% of the potato production, 29% of the nation's rice production, and all or nearly all of the nation's production of almonds, dates, figs, kiwifruit, olives, pistachios, raisins and walnuts (California Department of Food and Agriculture, 2013).
This analysis focuses on San Diego County. San Diego County has more farmland than Riverside County, Orange County or Los Angeles County (USDA, 2012). The county is also the second most populous in the state (behind Los Angeles County), and fifth most populous in the country (U.S. Census Bureau, 2014).

San Diego County is losing agricultural land at a very high rate. Over the past decade, the USDA Census of Agriculture estimates that the United States as a whole is losing about 0.13% of its total agricultural land every year (or about 1.2 million acres). The state of California is estimated to be losing about 0.8% annually (or 202,000 acres). San Diego County is losing an average of about 8.4% of its agricultural land every year (or about 18,600 acres). Since 2002, the amount of land in agriculture in San Diego County has nearly halved from about 408,000 acres of farmland in 2002 to 221,500 acres in 2012, a 46% decrease (Table 1a). It currently accounts for about 9% of the farmland loss in the state, even though the farmland accounts for less than 1% of land in the state. Excluding farmland lost to national forests, San Diego County has the highest rate of farmland loss of all 58 counties in California over the past decade. (USDA, 2002; 2012)

Table 1a. Annual farmland acres lost, 2002-2012

<table>
<thead>
<tr>
<th>Geography</th>
<th>Total Acres in Farmland 2002</th>
<th>Total Acres Lost 2002-2012</th>
<th>Avg. Acres Lost Annually</th>
<th>% of Acreage Lost Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>938,279,056</td>
<td>-23,751,399</td>
<td>-2,375,140</td>
<td>-0.13%</td>
</tr>
<tr>
<td>California</td>
<td>27,589,027</td>
<td>-2,020,026</td>
<td>-202,003</td>
<td>-0.79%</td>
</tr>
<tr>
<td>Orange County</td>
<td>68,018</td>
<td>-7,521</td>
<td>-752</td>
<td>-1.24%</td>
</tr>
<tr>
<td>Ventura County</td>
<td>332,371</td>
<td>-51,325</td>
<td>-5,133</td>
<td>-1.83%</td>
</tr>
<tr>
<td>Los Angeles County</td>
<td>111,458</td>
<td>-19,769</td>
<td>-1,977</td>
<td>-2.16%</td>
</tr>
<tr>
<td>Riverside County</td>
<td>572,036</td>
<td>-227,992</td>
<td>-22,799</td>
<td>-6.63%</td>
</tr>
<tr>
<td>San Diego County</td>
<td>408,003</td>
<td>-186,465</td>
<td>-18,647</td>
<td>-8.42%</td>
</tr>
</tbody>
</table>

Source: USDA Census of Agriculture, 2002 & 2012
Among this farmland in San Diego County, the single most important crop both in terms of acreage and production value is the avocado (County of San Diego Department of Agriculture Weights and Measures, 2014). San Diego County produces more avocados than any other county in the United States (about 37% of the nation’s crop), and was responsible for about 42% of the state of California’s crop of avocados in 2014, when data was last collected (California Department of Food and Agriculture, 2013; County of San Diego Department of Agriculture Weights and Measures, 2014). According to the California Avocado Commission, San Diego County has more acres in avocados than any other county in California, representing 35% of the total land area in avocados in the state. There are an estimated 18,400 acres of land in avocado groves in San Diego County (‘Acreage Inventory Summaries,” 2014). This is about 31% of the irrigated agricultural land in the county, making it the largest single crop in terms of acreage in the county (County of San Diego Department of Agriculture Weights and Measures, 2014).³ Avocados are the county’s highest-grossing single crop in San Diego County, accounting for over $150 million in agricultural production value (County of San Diego Department of Agriculture Weights and Measures, 2014).⁴ In short, San Diego County avocados are an important crop for the county, state, and the country as a whole. This study focuses on the avocado industry in San Diego as a special case for the agricultural industry in the county at large.

³There are different ways to measure and define “agricultural land” or “farmland” or “land in agricultural production” among different sources. Thus, the numbers used in table 1a (from the USDA Census of Agriculture) may not align perfectly with data derived from other sources, such as the San Diego County Department of Agriculture Weights and Measures (from which the data in this paragraph is derived).

⁴Decorative crops are counted together as a group, so have a higher production value than avocados in San Diego County.
Factors Driving Farmland Loss

Studies of farmland loss on the urban fringe tend to focus on a single factor: land values. This is no doubt an important issue that has large implications for the fate of land in agricultural use at the urban fringe. Indeed, as land values continue to increase in the urban core and state and local governments do little to curb current growth trends, the conversion of land from rural to urban uses in and around the urban fringe will likely continue without abatement. However, to only consider land values in assessing the drivers of farmland loss is to miss important factors contributing to the loss of land on the urban fringe.

For example, in the United States, the scarcity of accessible freshwater resources for all sectors is a mounting problem that is creating a heavy burden for agricultural communities, and few state or local governments are addressing it with adequate attention.
(Choy & McGhee, 2014). This is in part due to the arrangement of water resources governance institutions and in part due to natural constraints, and is true in the “water-rich” regions of the country—such as the Great Lakes Region, centered around the largest freshwater system in the world—as well as the arid regions of the American Southwest. In California—which is currently in the longest and most severe drought since records have been maintained (Figure 4g)—limited water resources is threatening the ability of the existing water resources to meet residential, industrial, and environmental needs. Even where the quantity of water is sufficient for human and environmental needs, in San Diego County the quality of the resources that do exist are often threatened by low-grade sources, outdated infrastructure, neglect, or preventable contamination (Personal Communication, farm bureau representative; water district representative).

Natural constraints to adequate and affordable water supply exist as well. San Diego County, for example, sourced an average of 64% of its water from the Colorado River over the past five years due to lack of available local sources (San Diego County Water Authority, 2015). The salinity of the Colorado River is so high when it reaches the inflows for the Metropolitan Water District of Southern California (MWD)—the water wholesaler for the San Diego County Water Authority (SDCWA)—it must be blended with higher quality water

5 In Wisconsin, for example, an application by a Waukesha County to divert water from Lake Michigan for municipal use as local aquifer resources are ostensibly being depleted and contaminated has been raising concerns with respect to the future of Great Lakes water (Schapiro, 2013).
6 The failure of man-made systems to deliver this water has been brought to light by recent high-profile cases of drinking water contamination in Flint, Michigan in 2015 and in Elk River near Charleston, West Virginia the year prior.
in order to be used by water districts in San Diego County and elsewhere (Vallecitos Water District, 2010).

Even if the water that comes through the pipe is usable and available in sufficient supply, it may not be affordable. The price of water sold by the SDCWA (which services 93% of the population of San Diego County) has more than doubled in the past decade (Table 4f). Though this may represent a relatively small burden for domestic and municipal users, for farmers, it is a significant cost.

Though there may be many factors affecting the agricultural sector in San Diego County, this analysis focuses primarily on the increasingly adversarial economic, political, and natural environments that have been identified by key stakeholders and growers themselves as significant drivers in the rapid decline of the San Diego agricultural sector. San Diego County is in many ways a microcosm of the planning challenges facing communities around the country and around the world, in particular with respect to the scarcity of resources for agricultural uses on the urban fringe. The relatively unique characteristics of the land in San Diego County and the rapidity with which changes are happening in the county, however, means the topics discussed in this work are especially salient and pressing, and it is hoped that this analysis may be of aid in shaping the future of the agricultural production system in San Diego County. It should be noted, though, that while these issues may be especially urgent in San Diego County, they are not unfamiliar to the rest of the country. So while its unique governance context makes it an ideal model for demonstrating the planning and environmental resource management issues at stake, many of the lesson learned in this analysis can be applied elsewhere, especially within California.
This thesis aims primarily to provide insight into the question: “What are the most important drivers shaping the agriculture production system in San Diego County in the past 10-25 years?” In answering this question, this work also touches on whether current trends in the agricultural sector in San Diego are indicative of a permanent restructuring of the agricultural production system in the county, and the extent to which this system is resilient to the increasingly volatile shocks and stresses with which it is being confronted.

Underlying Conceptual Bases

In seeking to answer the question above, approaches were needed that could best address the issues that seemed to be facing growers in the county. Four conceptual bases in particular informed the approaches taken to this research: transdisciplinarity, a systems perspective, resilience, and a problemshed approach. These are described briefly below.

Transdisciplinary Approach

Urban Planning is considered by many to be a field drawing from multiple disciplines (Kochitzky et al., 2006). Since this analysis is largely shaped by approaches used in urban planning, it is not unusual that it approaches challenges from multiple disciplines’ perspectives. Transdisciplinary research is characterized by research problems that “originate from non-scientific application contexts, and they are formulated in these contexts

---

7 Though the terms multidisciplinary, transdisciplinary, and interdisciplinary have different meanings, the precise definitions are often ambiguously defined and interchangeably used, even in academic literature (Choi & Pak, 2006). It is beyond the scope of this work to explore the nuanced differences between the different terms applied to integrative research. However, an overview of the literature defining this terms indicates that transdisciplinary best describes the approaches taken for this research.
independently of scientific theories and disciplinary definitions” (Balsiger, 2005, as cited in de Albequerque, 2007).

The benefits of taking a transdisciplinary approach are so that “research methods…follow research questions” (Johnson & Onwuegbuzie, 2004, p. 17-8). In the surveys and interviews administered as a part of this research, informants and growers identified the challenges facing the agricultural production system in San Diego County as complex and being driven by a diverse set of factors. Transdisciplinarity, coupled with a systems approach, holds great promise for understanding the dynamic nature of the San Diego County agricultural production system, as well as other complex systems (Stember, 1991).

**Systems Perspective**

In seeking to address the many challenges facing growers in San Diego County, an approach is needed that recognizes that there are many complex drivers shaping the environmental and socio-economic environments in which they operate. The challenges facing San Diego County growers are matters of systems resilience in the context of the agricultural production system and the larger food system in San Diego County, the United States, and the world. For this reason, this study favors the use the term “agricultural production system” instead of “agriculture sector” or other more common terms to emphasize the importance of seeing growers in San Diego County as part of a multi-scale food system with complex interactions and feedback loops, a broad constellation of policies, and a regional political economy (International Panel of Experts on Sustainable Food Systems, 2015).
The interactions between these drivers, system feedbacks, and the activities and outcomes in the food system are together what make the food system function (Figure 1b). As the food system drivers change and take on new forms, so do the feedbacks and outcomes. In short, as the drivers change, the food system changes.

Figure 1b. Food Systems: drivers and feedbacks


With respect to avocados in San Diego County, this analysis seeks to demonstrate how the most salient of these drivers and feedback loops are contributing to changes in the system. In order to assess the extent to which the San Diego County agricultural production system is beginning to change, the concept of resilience is used to understand how the agricultural production system in San Diego County might withstand the variety of stresses and shocks of the past several years and into the future.
Resilience

The concept of resilience has its roots in ecology, brought to prominence by C.S. Holling in the 1970s. Holling refers to the “resilient character” of natural systems, noting that the “long persistence in the face of...major changes suggests that natural systems have a high capacity to absorb change without dramatically altering” (Holling, 1973, p. 7).

Holling describes this as the “resilient character” of the natural system to dynamically adapt to change and return to its “domain of attraction.” He uses the concept of “domain of attraction” in contrast to the concept of equilibrium, in part to denote that there may be multiple domains of attraction, and that a system might evolve over time. Thus, Holling notes that a system’s “resilient character has its limits, and when the limits are passed...the system rapidly changes to another condition” (Holling, 1973, p. 7).

While Hollings saw resilience in ecological systems, others have sought to apply the concept in social science applications, asking “Is resilience a relevant term for describing communities?” (Adger, 2000, p. 348). Many have answered this question in the affirmative, though from various perspectives (Zimmerer, 1994; Gunderson, Holling, Pritchard, & Peterson, 1997; Levin et al., 1998). Thus, the concept of resilience has been expanded and adapted to various fields since the 1970s. Notably, resilience has been adapted to include social-ecological systems (SES), an application useful for the case of San Diego County agricultural production system. Folke et al. describe resilience in the context of social ecological systems as follows:

Resilience thinking addresses the dynamics and development of complex social-ecological systems (SES). Three aspects are central: resilience, adaptability and
transformability. These aspects interrelate across multiple scales. Resilience in this context is the capacity of a SES to continually change and adapt yet remain within critical thresholds (2010, p. 1).

Besides resilience, the two important concepts introduced in the above definition are adaptability and transformability. Though both of these concepts fit within the larger concept of resilience, the nuances of these concepts may best be understood in contrast to one another. Adaptability “represents the capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current trajectory,” whereas transformability “is the capacity to cross thresholds into new development trajectories” (Folke et al., 2010). As Walker et al. define transformability, it is, the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable (2004, p. 1).

To use the terms Holling introduced above, adaptability represents the ability of a system to maintain itself within its current “domain of attraction,” and transformability represents the ability of a system to maintain integrity even as its character changes and its moves to a new domain of attraction. As an example of transformability, Folke et al. use a hypothetical region that “moves from an agrarian to a resource extraction economy” (2010, p. 5).

The differences in these concepts are important, as they represent two different ways of envisioning the future of the agricultural production system in San Diego County. In one vision, the agricultural industry in San Diego County may exhibit high levels of adaptability remaining in more or less the same farm as it was a decade or so ago, despite intense changes.
The agricultural production system in San Diego County may also exhibit high levels of transformability, entering into new development trajectories as the current trends push the system into new domains of attraction. Depending on the scale and perspective of analysis, transformability could include shifting to an entirely new industry—as in the example provided by Folke above—or it could be a shift to an entirely new crop that requires different institutional access, new laws and policies, and a new market demographic. While many in the agricultural industry may see transformability as a lack of resiliency, by the definitions introduced, it may also be understood as an example of resilience in the larger social-ecological system.

The resilience that the agricultural system in San Diego County exhibits will depend on how the agricultural production system—and the supporting systems on which it relies—is able to adapt and transform given the stresses and shocks in the county.

**Problemshed Approach**

Finally, in addition to a transdisciplinary, systems-based approach, the scale of analysis is an important consideration for this study. Though the location of analysis is identified as San Diego County, this study approach recognizes that there are many drivers and factors outside the county that affect growers within the county. Therefore, this analysis utilizes a “problemshed” approach.

The problemshed as a concept that is at least as old as 1968, when it was used it to discuss environmental control from an economic perspective (Kneese, 1968). Since that time, the concept has gained popularity in the water resource and other resource-management literature. A problemshed approach, according to Viessman, is a “system-encompassing”
approach that ensures that the boundaries of policy and analysis “are defined by their true temporal, spatial, environmental, and institutional dimensions” (1998, p. 6). That is to say, analysis should not be defined by traditional environmental or political bounds—such as a single watershed or county—if these do not encompass the broader problems being addressed.

This is an especially important concept, for example, in exploring implications of water resource scarcity for the agricultural production system in San Diego County, which imports about 80% of the water it uses. According to the SDCWA, “[local water sources] haven’t provided enough water to meet all of the region’s needs since 1947” (SDCWA, 2015). Water used on San Diego County farms may originate as far away as the Rocky Mountains. Though this is in an entirely different watershed and state, analysis seeking to understand the issues of important for a San Diego County farmer should consider the context of the entire area affecting the agricultural production system.

A problemshed may be defined in a number of ways, and different political jurisdictions or areas may have tiered importance in terms of its effects on the SES in question. The problemshed on which this analysis focuses is shown in Figure 1c. This includes the watersheds of the Colorado River and the San Francisco River Bay-Delta, as well as the state of California. This does not mean other geographies are not considered; the importance of drivers at the national and international level affecting local agricultural systems is recognized in this work. The problemshed approach recognizes how the most important of these tiers shape political, environmental, social, and cultural factors driving the SES being studies, and is an approach whose importance is recognized by resource management agencies in California (California State Water Resources Control Board, 2014).
Methods

The challenges confronting agricultural communities in San Diego County are multifaceted, layered, and rooted in local contexts. Since “research methods should follow research questions in a way that offers the best chance to obtain useful answers,” analysis seeking to understand the factors driving urban land conversion must similarly be multifaceted, layered, and locally-sensitive (Johnson & Onwuegbuzie, 2004, p. 17-8).

In approaching this research through the frameworks outlined above, it was determined that single-method analysis would fall short of answering—and perhaps even asking—the appropriate questions needed to understand the complex issues facing the San Diego County agricultural production system. Given the complex nature of the research question and the many factors that affect development and loss of agricultural land in San
Diego County, this research question is “best and most fully answered through mixed research solutions” (Johnson & Onwuegbuzie, 2004, p. 18). Thus, in approaching this thesis, a mixed-methods approach was used to better comprehend the multiple factors that shape urban and rural development in San Diego County.

The methods chosen for this study were designed to draw from multiple sources, multiple perspectives, and in multiple formats to connect local idiosyncrasies with the broader literature on urban development and farmland conversion. These methods included archival research (historical documents and literature), quantitative analysis (grower survey and secondary data sources), and qualitative research (informant interviews and open-ended survey questions).

Archival research was carried out with the understanding that current events and trends are nondeterministic and are the result of contingent decisions made in history, and was meant to contribute to an understanding of the perspectives that people had with respect to agriculture and urban development in San Diego County and the American West in the past century and a half. Many of these documents were accessed at the San Diego History Center, the Love Library at San Diego State University, and the Wisconsin Historical Society’s library. Documents and sources were also accessed online through various websites. Academic journals and gray literature were also referenced extensively.

The largest source of quantitative data used for this study were secondary data sources. Agencies and organizations from which secondary data was gathered include the San Diego County Department of Agriculture Weights and Measures (DAWM), the Brookings Institute, the United States’ Bureau of Labor Statistics (BLS), the National Oceanic and Atmospheric Administration (NOAA), the Hass Avocado Board (HAB), the
California Department of Conservation (CDC), the United States Census Bureau, the SDCWA, and the USDA Census of Agriculture. Data from these sources were compiled and analyzed in order to gain a clearer understanding of the social, economic, and demographic trends affecting the county, the state, and the nation as a whole.

In addition to secondary quantitative data, an important aspect of the research protocol was the collection of original survey results from the primary operators of farms in San Diego County. The grower survey was designed to collect information about the factors that farmers in the county understood as most important in shaping their management decisions and their decisions to convert land to new uses. The survey was divided into four themes: basic farm information; water sources; management decisions; and large-scale trends shaping the regional industry (see survey questionnaire in Appendix 1). The surveys targeted avocado growers and were distributed via an online link that was sent to growers by stakeholder agencies, including the San Diego County Farm Bureau (SDCFB), the University of California Cooperative Extension (UCCE) Division of Agriculture and Natural Resources, and the UCCE subtropical farming group of San Diego County.

Qualitative data was gathered through a series of semi-structured interviews undertaken with key informants in the county. These informants represented a diverse group of stakeholders, including units of general local government, water districts, processing facilities, extension services, growers, and non-profit organizations. In total, eight formal interviews were facilitated, recorded, and transcribed. Open-ended questions were also included in online surveys sent to growers in the county, and constitute important qualitative data.
Research Limitations

Though care has been taken in the design and implementation of this research, there are several limitations that should be highlighted. The first, and perhaps most noteworthy, is the numbers of survey respondents was lower than the targeted sample size. Due primarily to geographic constraints, the researcher was not physically present during much of the survey implementation. The surveys were administered online through a link that sent through newsletters and other online media that growers would be likely to see and read. The online format was the most expedient given the circumstances, but had several important implications, not least of which was a small sample size. This led to a relatively small percentage of the study population responding to the survey at all (n=49), and an even smaller number of the respondents completing the entirety of the survey (n=29). Some of the questions are directed only at avocado growers. For these questions, the sample size is even smaller (n=20 up to n=26, depending on the question). Because of the small sample size, the conclusions that are reached in this analysis based primarily on survey responses are analyzed and couched in language indicating their relative under-representation.

Another important implication is potential selection bias based on the fact that respondents voluntarily clicked through a link in order to complete the survey. Though results in Table 4a indicate that this bias may be minimal, selection bias may still exist due to the method of survey distribution.

Additionally, the methods described above may best be described as aspirational. The complexities of any system are far too intricate to be fully explicated by a single master’s
thesis. The most salient points have been selected as points of emphasis; however, there are undoubtedly gaps.

**Orientation to Remainder of Document**

Making use of the frameworks outlined above, the remainder of this work describes how resource scarcity—particularly land and water resources—is being addressed in San Diego County. Chapters 2 and 3 describe the San Diego agricultural production social-ecological system (SES): Chapter 2 outlines the historical and institutional context around the agricultural production system in San Diego County, while Chapter 3 describes the biophysical and environmental considerations that must be addressed for the continued production of avocados in San Diego County. Chapter 4 summarizes the various trends—the disturbances, shocks and stresses—that have influenced the agricultural production system in San Diego County the past 10-25 years. Chapter 5 synthesizes the information from the previous chapters to speak to the resilience of the San Diego County agricultural SES. Chapter 6 provides some concluding remarks, and notes a few potential systems-strengthening solutions that are either already being implemented in San Diego County, or may be implemented in the future.

The factors affecting the research question addressed by this analysis are important considerations for San Diego, for California, and for the United States as a whole. There is an adage not often applied to the agricultural sector: “As California goes, so goes the nation.” The veracity of this statement notwithstanding, the San Diego region is currently at a pivotal juncture and is uniquely situated to address its planning challenges. San Diego County is quickly reaching its natural barriers as its population grows and resources are stretched thin.
In many ways, San Diego County is currently confronting questions that will become more common for communities in the United States in coming decades as resource scarcity increasingly becomes a factor shaping practice and analysis in environmental resource management and urban planning.
Chapter 2
San Diego Agriculture: History, Context, and Institutions

“Government policies are not favoring farmers as to land use, pesticide and fertilizer use, marketing, water regulation and quality.”

“All these [policies and innovations] are good, but it is not determined if these can overcome the basic farming economics.”

-Avocado Growers in San Diego County

The purpose of this chapter is to provide historical and institutional context for understanding the factors shaping the San Diego County agricultural SES. There are five sections in this chapter. The first describes the broad historical development of San Diego County, covering the important historical events that have shaped the agricultural institutional context of San Diego County today; the second section describes the geographic and social context; the third section outlines the political institutional context in San Diego County, especially with respect to agricultural; the fourth section of this chapter gives the historical and institutional context surrounding water resources in the region; and the final section describes the agricultural institutional context in the county.

Highlighting the historical institutional context of the San Diego County agricultural production system demonstrates that the current developments in San Diego County are historically conditioned by contingent decisions made by governing bodies, private corporations, or social actors. That is to say, the current state of the system was not an inevitability, has been developing over time, and will continue to develop. It also brings to relief the multiple overlapping systems at play in the San Diego County agricultural SES. We begin with a short history of the region.
The Legacy of History

The Mission Era

Mission San Diego de Alcalá was the first Spanish settlement in what would become California, and was founded in 1769. San Diego was the first of twenty-one Spanish missions founded in Alta California during Spanish reign from 1769-1820, and for this reason it is often called the “mother of the California missions.” For much of its existence, it served as a military and trade center, as well as the primary center of Euroamerican civilization in the region (McKeever, 1994, p. 37; Englehardt, 1920).

In addition to Mission San Diego, Mission San Luis Rey de Francia was founded in 1798 in what would become San Diego as the eighteenth of the twenty-one California missions. If San Diego was the “mother” of the California missions, San Luis Rey was the “king” (Engelhardt, 1921; “San Luis Rey de Francia,” 2014). At 950,400 acres (or 1,485 square miles), the San Luis Rey mission was the largest mission in California, larger than the present-day state of Rhode Island. It even had a sub-mission (“asistencia”) called Mission San Antonio de Pala to serve its far-flung constituents (“San Luis Rey de Francia,” 2014).

The San Luis Rey mission is for all intents and purposes the precursor to the agricultural industry in San Diego County today. Known for its agricultural output, the mission lands near the fertile San Luis Rey River valley boasted a vast agriculture and irrigation system. With above-average rainfall for the region and proximity to a perennial river, Mission San Luis Rey’s produced large yields of wheat, barley, corn and beans in its early years (SDCWA, 2014; Engelhardt, 1921). Over eighty acres of orchards and vineyards
also belonged to the mission at its height, known for its wine grapes, citrus, and peppers. Early accounts describe the mission’s agriculture as such:

There are also a vineyard, and an orchard of various fruits and of olives, for which there is sufficient irrigation, the water being from the stream which runs to the vicinity of this Mission…The vast gardens and orchards with numerous fruit trees, and well cultivated, supply abundant vegetables and fruits of all kinds…These orchards grow most exquisite olives and produce the best grapewine in all California…(Engelhardt, 1921, p. 51, 57)

The agricultural legacy of this mission should not be underestimated; still today, the Pala asistencia sits in Pauma Valley within eyesight of hundreds of acres of avocado and citrus orchards. The San Diego mission became a much more urban, military mission, and is one of only a few California missions to be granted the status of presidio and then pueblo while under Spanish and Mexican rule. Though the two missions—San Diego and San Luis Rey—no longer serve their original purposes, they represent two competing visions for San Diego: one urban, and one rural.

**Growth and Restructuring**

The mission era came to an end in 1820, when Mexico gained independence from Spain. From 1821 to 1836, San Diego functioned primarily as a military outpost ("presidio") for the Mexican government, a function that is still important for the region. In 1836, Mexico granted San Diego the status of pueblo, which gave it the right to a municipal
government (McKeever, 1994). In 1848, the Treaty of Guadalupe-Hidalgo ended the Mexican-American War and made California—and San Diego—a part of the United States; a year later, in 1849, gold was found near a mill owned by John Sutter near Sacramento, setting off massive migration to the new U.S. territory (“Timeline of San Diego History,” 2015). Though this greatly boosted the population of the new territory of California, the region around the city of San Diego remained relatively sparsely populated by Euroamerican settlers (San Diego History Center, 2015).

In California’s storied history, San Diego has only rarely been the focal point of the state’s great movements; for a city of its size, it is relatively isolated and removed. The isolation of San Diego County—geographically, economically, and politically—may be the most important factor shaping its identity and development over the decades. This isolationism has led to an attitude that water resources professionals refer to as the “end of the pipeline syndrome,” taken from the fact that San Diego County is at the end of state’s large water pipelines. The implications of this isolation are important, and will be emphasized later.

There are two major events in the history of San Diego County that are generally recognized as having led to a restructuring of regional politics and economics. The first was the completion of the railroad in August of 1883 that connected San Diego to the rest of the

---

8 This designation would also have implications for water rights in the future, as a city designated as a “pueblo” under Mexican rule gained preeminence with respect to water rights under United States law. This is a convoluted legal-historical point that has little practical implication today, but is an interesting aside nonetheless.
nation. Between the census counts of 1880 and 1890, the population rose from 8,600 people\(^9\) living in San Diego County to about 35,000, with an estimated peak in 1887 of about 70,000 people (San Diego History Center, 2015). What had once been an isolated hamlet on a deep bay south of Los Angeles, was becoming a major destination for tourists and settlers, and its ideal climate was a draw for those wishing to stake their claim in agriculture.

The second event of great significance to the growth of San Diego County was the intense military buildup in the county during the United States’ entrée into World War II. When war with Japan was deemed a serious threat to national security, the U.S. Navy poured funds, development efforts, and people into San Diego County (McKeever, 1994, p. 119-20). This pouring of federal funds into San Diego is probably the most important relic of San Diego’s history that still plays out tangibly in its economic and social life today, in large part due to its implications for water resources for the county.

The SDCWA was formed and became part of the MWD in 1944 as a direct result of this buildup and the need to provide water for the exploding population (Golakoff, 2013). Whereas San Diego had previously existed in rugged self-sufficiency, the region was suddenly cast into the contentious regional fray for water. Additionally, the WWII years saw San Diego County double in population (Pourade, 1960). Even after the war was over, San Diego had become a large and growing political and economic force in the far southwest corner of the country.

\(^9\) This count only includes white residents living in the county
Geography and Social Context

San Diego County is the fifth largest county in the United States by population with nearly 3.3 million people living in the county, and by area it is roughly the size of the state of Connecticut; it is the largest Metropolitan Statistical Area (MSA) in the United States entirely contained within a single county, implying a unique governance context for the region (US Census Bureau, 2014). This fact is in large part due to the four relatively fixed borders of the county that hinder the spillover and connections with other counties and metropolitan areas that might be expected in a southern California context, and which have contributed to the isolated nature of the county mentioned above:

- the southern border of the county is the international border with the Mexican state of Baja California
- the northwestern corner of San Diego County is owned by the federal government as part of the Marine Corps Base Camp Pendleton, and is kept more or less in a natural state for desert and amphibious military training exercises;
- the eastern and northeastern parts of the county are rugged and are likely to remain relatively unpopulated in coming decades;
- the Pacific Ocean to the west creates a fixed border for the county and metropolitan area.

---

10 If not for the international border, Tijuana would undoubtedly be considered part of the San Diego MSA. As it is, the the San Ysidro Port of Entry between the two cities is considered the busiest international land-based point of entry in the western hemisphere, with over 75,000 people crossing the border every day in just one direction. Additionally, there are two other land-based ports of entry in San Diego County, Tecate and Otay Mesa, the latter of which is considered to be one of the busiest land-based cargo ports of entry in the world (US General Services Commission, 2016).

11 Camp Pendleton and sheer distance have historically separated the Los Angeles Metropolitan Area and the San Diego Metropolitan area. However, in recent years, urban expansion in Riverside County and in northern San Diego County have meant that urban areas are beginning to meld together. Camp Pendleton is larger than the entire city of Chicago and more than a third of the size of neighboring Orange County. It will likely remain unpopulated interminably, creating a buffer to San Clemente, Irvine, and the rest of the Los Angeles megaregion.

12 Within 70 miles of the coast, elevations rise from sea level to over 6,000 ft, and then drop back below sea level into the Salton Sink in the Sonoran Desert - one of only three places in the Americas that is below sea level. The ruggedness of the terrain combined with the inhospitable nature of the desert means that San Diego is not likely to expand east too quickly.
These relatively fixed borders mean that San Diego County has the unique ability to govern the entire metropolitan area under a single entity, and likely will for some time.¹³ This is true not only for units of general local governance, but also for special districts. This has its benefits, to be sure, but it comes with its own set of difficulties, specifically in balancing the needs of a diverse set of stakeholders with only the tools and powers of a local government.

**Political and Economic Context**

The political and economic context of California and San Diego County is unique and multifaceted. This study touches on four important aspects of the economic and political context, as they have immediate implications on the agricultural community in San Diego and the ability of the political institutions to affect change. They are: the concept of home rule at the county level in California, and specifically in San Diego County; the effect of tax reform on the development of avocado agriculture in the region; the implications of Proposition 13 on water rates and the agricultural community, specifically with respect to water district financing; and the use of the special districts in California and the United States as a whole as a means of governance.¹⁴

---

¹³ It should be noted that along Interstate 15 in the north central part of the county, commuting patterns are beginning to shift so that many people in Temecula (in neighboring Riverside County) are beginning to commute further distances. Though it is still not considered part of the San Diego MSA, the lines are beginning to blur between the San Diego MSA and the Riverside MSA.

¹⁴ From an international standpoint, the political structure of the United States is relatively decentralized in terms of the locus of power. In basic constitutional law, the states are ostensibly where power presides, a power codified in the tenth amendment of the United States Constitution, where all powers "not delegated to the United States by the Constitution...are reserved to the States. (U.S. Const., amend. X)"
Home Rule

Because states have so much power in the United States, there is a great diversity of institutional arrangements among the states. Though the literature on the shared power between municipalities and the state is relatively extensive, the literature on the power granted to counties is less rich. This may be because “counties have traditionally been considered the administrative arm of the state and, consequently, have not needed broad powers” (Timmons, Grant, Popp, & Westby, 1993, p. 815). However, the role of the county is an important one, especially in the context of this analysis.

As San Diego County grew and became an important player in regional and state affairs, its unique governance context contributed to its ability to negotiate for the needs of a large and diverse population. Though the San Diego governance context is unique, it is situated within the institutional context of the state of California and the United States.

A state is said to have home rule (often called Dillon’s rule) when that state allows local municipalities to make any law, policy, tax, etc. that is not specifically prohibited by the state in the state’s constitution (Stroud, 2013). Many states are considered “home rule states,” meaning their constitution or legislature have given all or some non-enumerated state powers to municipalities or counties. California is such a state, with the following provision in article 11, section 7 of its constitution: “A county or city may make and enforce within its

---

15 While this may prima facie seem like an iteration of federalism, it actually is working the opposite direction. In the federalism of the United States, the states (the smaller entity) are where ultimate power resides. This is not nested federalism as much as it is another indication of the dominance of the states. Thus, the significance of home rule is made clear, since without it, municipalities (or counties) could be preempted by actions at the state level.
limits all local, police, sanitary, and other ordinances and regulations not in conflict with
general laws.”

Even within its home-rule provision, California is relatively unique, first, because it is fairly expansive in the powers granted to the cities and counties (Vanlandingham, 1968). Second, California was one of the first states to consider that counties could be a “creature of the state” rather than an arm of the state by introducing the concept of charter counties (Burns & Gamm, 1997). A charter county in California has a limited degree of home rule authority beyond the general law (California State Association of Counties). While this does not grant the county sweeping powers, it does allow a certain amount of autonomy that, combined with the fact that the San Diego MSA and County are coterminus, could have profound implications with respect to farmland preservation and urban development on county-controlled lands outside of municipal boundaries.

---

16 This provision has a long history that makes its interpretation far from clear (Ca. Constitution. 1849. (repealed 1879)). The above section was added in the 1879 revision of the California constitution - along with many other limitations of the power of the state legislature (Peppin, 1944; Stroud, 2013) - the effects were immediately tangible: cities and counties were considered to have a considerable amount of flexibility within their jurisdictions.

17 Whereas Missouri, for example, is recognized as the first state to allow home rule, it did not allow it in any other city this privilege except St. Louis (Schmandt, 1953). California originally allowed it in many cities, and has expanded this power since its adoption.

18 San Diego County, the City of San Diego and at least seven other cities in San Diego County are chartered, and may exercise more power in the way they organize and implement local governance than general cities or counties (California State Association of Counties). At least three of these chartered cities in San Diego County are in communities with substantial agricultural communities. These powers are not expansive, but they serve to illustrate the relative power of counties in California.
The Tax Reform Act of 1969

In the early 1970s, “special farm tax provisions, especially cash accounting and the…deduction of orchard development costs, provide[d] significant development incentives” for avocado grove in San Diego County (Carman, 1981, p. 165). Indeed, between 1970 and 1985, avocado acreage in San Diego County more than tripled from 10,380 acres in 1970 to 35,350 acres in 1985 (Figure 2a).

Figure 2a. Acres in avocados in San Diego County, 1955-1981

Many experts point to the Tax Reform Act of 1969 as especially significant for the development of avocado orchards in San Diego County and elsewhere. Previous to the Tax
Reform Act of 1969, citrus farm owners could deduct the cost of orchard development from their taxes. This created a tax loophole in which non-farming entities could establish an orchard and deduct all development costs from their taxes. The farm would be operated as a typical non-bearing orchard would be operated, and could be sold with only capital gains taxes before the orchards reached bearing age (Woods, 1970).

This loophole was closed by the Tax Reform Act of 1969 for citrus orchards; however, the act allowed non-citrus orchards and vineyards to operate under similar rules. In the words of one analyst in 1971:

The assets involved [i.e., non-citrus orchards and vineyards] require several years to mature and, during the pre-operation period, the development costs such as water, fertilizer, cultivation, pruning and spraying may be deducted as ordinary expenses of the business. When the operation reaches the stage where it is ready to begin producing a profitable crop, the asset may be sold in a transaction which qualifies for the lower capital gains tax rates (Davenport, 1971).

This analysis also cites a University of California Agricultural Extension report titled, *An Analysis of Orchard Development Costs* that estimates the cost of development of one acre of avocado at $4,395 per acre per year, much higher than the $1,255 for almonds or $1,745 for apples (Davenport, 1971).

Give the high cost development and the fact that avocados could grow in the San Diego County climate, the development of avocado orchards exploded in the region after citrus orchards no longer were viable in terms of receiving tax deductions.
Proposition 13 (or “The People's Initiative to Limit Property Taxation”)  

Proposition 13 is one of the most well-known and well-studied voter initiatives in California history. Going into effect in June 1978, Proposition 13 was overwhelmingly passed by initiative by about 65% voters (“What is Proposition 13?”). Ostensibly, it was a response to high taxation of real property, and was intended to keep fixed-income earners and other residents from being priced out of their homes, as well as to maintain a “necessary constraint on the size of government” (Chapman, 1999, p. 2). As land values—and ad valorem property taxes—were increasing dramatically, Proposition 13 was intended to be a sensible solution to keep Californians in homes they owned by capping the amount that property taxes could be raised and untethering property taxes from rising land values (Wasi & White, 2005).19

Wasi and White (2005) undertook a study researching the lock-in effects of Proposition 13, as well as the so-called “Proposition 13 subsidy” (the amount by which property taxes were reduced due to Proposition 13). In the San Diego MSA, it is estimated that the Proposition 13 subsidy was more than $1,300 per household in 2000. Calling the reduction in property taxes mandated by Proposition 13 a “subsidy” highlights one of the most important unintended consequences of Proposition 13: that it amounted to a loss of revenue for governments—specifically special districts—that would make it difficult for these units of governance to operate as they had previously. In rural communities where land

19 At least one report suggests that Proposition 13 did have this intended “lock-in” effect, with the average tenure of homeowners in California increasing by 1.04 years. In coastal cities where land values are highest, the average tenure length increased by 2-3 years following Proposition 13.
values are relatively stable, the effects of Proposition 13 are relatively small, since land values may not be increasing beyond the cap. For urban communities—especially those communities along the southern coast and in the bay area that saw rapid rises in land values in the 1970s—Proposition 13 provided a substantial tax relief. In 2000 in the San Francisco-Oakland-Vallejo MSA, taxes were reduced by an average of nearly $3,500 per household, the most of any MSA in California. Bakersfield—a city in the Central Valley known for its roots in agriculture—saw the smallest average reduction in taxes of any California MSA as a result of Proposition 13 at only $110 per household. The second lowest was Fresno, another agricultural community, with $457 in tax reductions per household. Though even Fresno and Bakersfield are large cities, the general trend is illustrated—large coastal cities saw a greater reduction in their taxes due to Proposition 13 than did inland, agricultural communities. Or, to put it another way:

An unintended effect of Prop 13 was to transfer public funds from inland to coastal California residents...higher property values...would normally have led to a transfer of tax revenue from coastal to inland California, since property values are higher on the coast. But because Proposition 13 holds down property tax collections, the transfer was much smaller (Wasi & White, 2005, p. 87)

San Diego County is one of the few counties in California where both rural inland and urban coastal communities exist under one unit of governance. This is true both of units of general local governance (i.e., the County of San Diego), and of special governance districts, including water districts (i.e., the SDCWA).

The effects of Proposition 13 are legion, and most are beyond the scope of this paper. The most significant for the purposes of this paper is that Proposition 13 led to a complete
Restructuring in the way in which state-local funds were apportioned, with the effect that the property tax played much less of an important role in finances at the local level, especially for special districts such as water districts (Chapman, 1999).

**Special Districts**

Special districts (or special-government districts or special-purpose districts) in the United States are units of local government that usually carry out specific tasks for the public good. Special districts are important in the local governance institutional context, especially in California. California has over 2,800 special districts (not including school districts), the second most in the United States (Figure 2b and Table 2a).

**Figure 2b. Growth of special districts in the United States**

![Graph showing growth of special districts in the United States](image)

Source: United States Census Bureau, Factfinder

**Table 2a. Special districts in the United States and California**

<table>
<thead>
<tr>
<th>Year</th>
<th>United States</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>18,323</td>
<td>1,962</td>
</tr>
<tr>
<td>1967</td>
<td>21,264</td>
<td>2,168</td>
</tr>
<tr>
<td>1972</td>
<td>23,885</td>
<td>2,223</td>
</tr>
<tr>
<td>1977</td>
<td>25,962</td>
<td>2,227</td>
</tr>
<tr>
<td>1982</td>
<td>28,078</td>
<td>2,506</td>
</tr>
<tr>
<td>1987</td>
<td>29,532</td>
<td>2,734</td>
</tr>
<tr>
<td>1992</td>
<td>31,555</td>
<td>2,797</td>
</tr>
<tr>
<td>1997</td>
<td>34,683</td>
<td>3,010</td>
</tr>
<tr>
<td>2002</td>
<td>35,052</td>
<td>2,830</td>
</tr>
<tr>
<td>2007</td>
<td>37,381</td>
<td>2,765</td>
</tr>
<tr>
<td>2012</td>
<td>38,266</td>
<td>2,861</td>
</tr>
</tbody>
</table>

Source: United States Census Bureau, Factfinder
The California state code defines special districts as “any agency of the state for the local performance of governmental or proprietary functions within limited boundaries” (Cal. Const. Art. XIII § 16271).

After the passage of Proposition 13, special districts could no longer rely on general property taxes to fund improvements in their districts. Instead, special districts increasingly were forced to rely on user fees for their funding. The following is from the California State Code:

The Legislature finds and declares that… [special districts’] ability to raise revenue directly from the property tax for district operations has been eliminated by Article XIII A of the California Constitution. It is the intent of the Legislature that such districts rely on user fees and charges for raising revenue. (Cal. Const. Art. XIII § 16270, [emphasis added])

The most important special district in San Diego County for the purposes of this study is the SDCWA, a member organization of the MWD, the largest public water supply agency in the United States. Being a public entity, it was previously able to draw much of its revenue from ad valorem property taxes, and was able to subsidize the cost of water for agricultural use by the higher taxes being paid by homeowners along the coast, where land values are highest.

Unlike most places in California, in San Diego both urban and rural communities are served by the same water district. As Proposition 13 came into full effect, it generally only had a small effect on farmers in the state; for farmers in San Diego County, however, it was
especially burdensome, as agricultural water users had previously enjoyed a system in which water infrastructure costs were shared across sectors and across the county.

Water Resources Institutions and Policy

Water development—and the institutions that enable it—has been a significant factor in the prosperity of the San Diego region at least since the San Diego mission dammed the San Diego River in 1807 and built a six-mile aqueduct to deliver water to the mission’s fields (“SDCWA History”). After California became a part of the United States, private land and water companies began the effort of water development with the hope of attracting settlers to the region. Since the formation of the SDCWA in 1944, the role of water provision for the county has been primarily in the hands of public entities.

Beyond the extensive institutions that provide water for the residents of California, there are also hundreds of policies, laws, and regulations shaping the water resource policy environment. A comprehensive overview of these policies and institutions would require volumes; this work highlights only a few of the most important components of the water resources institutional context in San Diego County. First, it provides a brief history of water development in the county, as this is important for understanding the current situation surrounding water in San Diego County. Second, it provides a brief overview of the most important water management agencies and organizations for this analysis. Finally, it touches briefly on water rights considerations and the larger-scale policies surrounding water use in San Diego County, including state-level policies and interstate agreements.
History: Private Water Development and Agriculture

One of the first large-scale water development efforts in San Diego was carried out by The San Diego Flume Company (SDFC). The SDFC was formed in May 1886 to construct a dam in the relatively wet mountains east of the city and build a gravity-powered flume to carry the water nearly 40 miles from there to the city of San Diego (Lakeside Historical Society). This flume brought the water necessary for agriculture and settlement in the early years of San Diego, and was an important factor in creating an environment in which agriculture in the region was touted as both possible and profitable.

There were many other companies that were involved in the development of land and water in San Diego’s early years, including the Junipero Land and Water Company (JLWC). The JLWC was important in bringing agriculture to the county, primarily because of its colorful advertising and the irrigation water that the SDFC had “provided for and will soon become available.” In this same pamphlet, they go on to extol the natural resources of the region in depth:

With rich land, plenty of water, an entire absence of epidemic diseases, with winters free from snow, ice, or killing frosts, and...where can be grown in abundance oranges, lemons, olives, grapes, guavas, berries, in fact all the fruits, both large and small, of the temperate and semi-tropical climate...with everything in such quantities

---

20 In 1887 the Junipero Land and Water Company (JLWC) was organized, a major player in bringing settlement to San Diego. Its purpose was to “to purchase, own, hold, cultivate, improve, subdivide and sell real property in the County of San Diego.” In an early pamphlet advertising for settlement in the San Diego River valley (“Mission Valley”), the JLWC promoted “the finest fruit and grape land” with “wonderfully rich” soil. Although they mention the need for irrigation, they are quick to assure that irrigation water “is provided for and will soon be available,” noting that “The Flume Company have nearly completed water works to bring an immense supply of water from the high mountains forty miles from the east.”
as to make it difficult for those who have not seen, to believe (San Diego History Center)

JLWC concluded that “For cultivation, residence, health, comfort, and profit, this tract is not excelled in the world.” The JLWC was not selling land so much as they were selling a vision of a paradise of abundant resources—including water—for residential living and agriculture.

Others with less financial interest involved, such as historian T.S. Van Dyke, described San Diego County in this way in 1883:

San Diego County…is anything but inviting to the settler or tourist. Hard, gravelly table-lands, either barren or clad with a dreary black brush, rolling hills of gravel bristling with cactus and cobble-stones, stony slopes scarred with gullies and washes, no tress, no streams, no springs…nowhere does [a visitor’s] eyes rest upon anything even suggestive of farming or rural life (as cited in McKeever, p. 85)

In spite of the relatively unfriendly nature of much of San Diego County with respect to agriculture in the region, it is largely due to the efforts of companies such as the JLWC and the SDFC that San Diego was ever able to support agriculture on a level of any significance.

History: Public Water Development

The early history of public water development in the county was primarily a matter of individual water districts building dams on local rivers and distributing the water nearby.

After the United States entered World War II, the federal government began to see San Diego— with its large, deep, and protected bay on the Pacific—as an important military asset.

In the four years between the 1940 census and the height of the buildup in 1944, the population of San Diego County increased from around 200,000 to 450,000 (Pourade, 1960).
A 1944 communication between President Franklin Roosevelt and the Bureau of Reclamation’s Assistant Commissioner William Warne reflects a certain panic associated with this uncontrolled growth. “This extraordinary increase placed a great strain on many community facilities,” the report reads:

“An emergency impends in the water supply of the city of San Diego and surrounding communities...The Colorado River offers the only available source from which an adequate, dependable supplemental water supply can be obtained for the area.” (Pourade, 1960)

The memo identifies two options for San Diego County to achieve a larger water supply, both requiring water from the Colorado River: either extend the All-American Canal, which at that time closely paralleled the Mexican border from south of Lake Havasu into the heart of the Imperial Valley; or extend the Colorado River Aqueduct, which ended at that time in San Jacinto, CA (about 70 miles away from a viable endpoint in San Diego). The first option was estimated to cost more than $24 million, would need to lift water more than 3,000 feet, would require a tunnel more than 7 miles in length, and would take more than 3 years to complete. The second route, though longer, would cost closer to $17 million, would be largely gravity-powered, and would pass near the large Marine Corps Base Camp Pendleton. Needless to say, the latter option was chosen.

The SDCWA, which acts as the water retailer for nearly all of San Diego County, was created a few months prior to the above-mentioned communication in preparation for a large water project (“SDCWA History”). After the northern route via San Jacinto was chosen for the Colorado River connection, the SDCWA became a part of the MWD. The MWD is a water wholesaler, selling water to its 24 member agencies, spanning six counties and serving
about 19 million people (“MWD Member Agencies”). The SDCWA is the largest member agency of MWD by area and by water use, and is itself a water wholesaler for 24 of its own member agencies: 6 cities, 5 water districts, 3 irrigation districts, 8 municipal water districts, 1 public utility district, and 1 federal agency (Marine Corp Base Camp Pendleton) (“SDCWA Member Agencies”).

The pipeline from the MWD to SDCWA was completed in November 1947—two years after the War had already finished—and began the era of San Diego County dependence on imported water and the MWD that continues today (Golakoff, 2013; Table 5b).

Principal Water Management Organizations and Institutions

The SDCWA is by far the most powerful stakeholder with respect to water use and distribution in San Diego today. At least 83% of the water available for use in San Diego County runs through a SDCWA-managed project (“SDCWA Imported Supplies”).

Perhaps the most notable of the other water organizations in San Diego County is the San Diego Regional Water Quality Control Board (SDRWQCB). The SDRWQCB is one of nine regional offices of the California State Water Resources Control Board (SWRCB), created successively by the Dickey Water Pollution Act of 1949 and the Porter-Cologne Water Quality Control Act of 1969. It combined the State Water Rights Board and the State Water Resources Control Board and created the nine Regional Water Boards (State Water Resources Control Board, 2013). The boundaries of these nine regional boards were drawn along regional watershed lines, according to the “unique differences in climate, topography, geology and hydrology for each watershed” and the differences in “recreational, agricultural,
and industrial development, all of which vary from region to region (California State Water Resources Control Board, 2014). The San Diego Region is shown in Figure 2c.

The mission of the SWRCB is “to develop and enforce water quality objectives and implementation plans that will best protect the State's waters” (California State Water Resources Control Board, 2014). In simpler terms, the SDCWA manages the water distribution and quantity, and the SDRWQCB manages water runoff and quality.

Figure 2c. San Diego Regional Water Quality Control Board

Source: San Diego Regional Water Quality Control Board, http://www.waterboards.ca.gov/sandiego/

Another key institution in water management in San Diego County is the Integrated Regional Water Management Plan (IRWMP), which was put together by San Diego County, the City of San Diego, and the SDCWA. IRWMP organizes region-wide watershed planning, bringing together stakeholders to create a comprehensive regional water plan with in-depth data analysis and meaningful collaboration. The most recent plan involved over thirty-four stakeholders (San Diego Integrated Regional Water Management, 2013). The
IRWMP has created two planning documents to date: one in 2007, and an updated version in 2013 (San Diego IWRM Region, 2013).

**Interstate Water Agreements**

The most significant water resources management institution in the American West is a complex of laws, cases, treaties, and compacts pertaining to the Colorado River collectively known as the “Law of the River.” The foundational document for this Law of the River is the Colorado River Compact (CRC) of 1922. The CRC sought to “provide for the equitable division and apportionment of the use of the waters of the Colorado River System” (*Colorado River Compact*, 1922, p. 1). It brought together the seven states that fall within the Colorado River Basin and sought to collectively manage and divide rights for the roughly 15 million acre feet that annually flows through the river (US Bureau of Reclamation, 2008). This has led to a complex arrangement enabling water trading, water transfers, and water banking. The 15 million acre feet is divided among the states in the Upper Colorado Basin (Colorado, New Mexico, Utah, and Wyoming) and those in the Lower Colorado Basin (California, Arizona, Nevada): a total of seven states. Table 2b shows how the water was originally distributed among the states.  

---

21 It is disputed exactly how much water is available in the Colorado River. These estimates of 15 million acre feet were made during wetter-than-average years, and many point out that 15 million acre feet may be more hopeful than reality.

22 It is worth noting, however, that these are maximum allocations, and that many states have not historically used all of their allocation. It is also worth noting that there are many ways to get around the limit, especially for California. California was permitted to use other states' allocations if they could not use them. In recent years, this has become problematic, as the other states – in particular Arizona – have begun to use their full water allotment, either through immediate use or through water banking.
Table 2b. Original allocation of Colorado River water

<table>
<thead>
<tr>
<th>Water Right Holder</th>
<th>1922 Allocation [Million acre-feet]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper Basin</strong></td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>3.88</td>
</tr>
<tr>
<td>New Mexico</td>
<td>0.84</td>
</tr>
<tr>
<td>Utah</td>
<td>1.73</td>
</tr>
<tr>
<td>Wyoming</td>
<td>1.05</td>
</tr>
<tr>
<td><strong>Lower Basin</strong></td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td>2.8</td>
</tr>
<tr>
<td>California</td>
<td>4.4</td>
</tr>
<tr>
<td>Nevada</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Later additions (subtracted from original 1922 allocations)</strong></td>
<td></td>
</tr>
<tr>
<td>Mexico (1944 Treaty)</td>
<td>1.5</td>
</tr>
<tr>
<td>Indian Tribal Rights</td>
<td>Various</td>
</tr>
<tr>
<td>Environmental Base Flows</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Total Estimated Flow</strong></td>
<td>15</td>
</tr>
</tbody>
</table>

Source: United States Bureau of Reclamation
http://www.usbr.gov/lc/region/gl1000/lawofrvr.html

Since the passing of the original compact, provisions have also been made for base flow of the river, as well as water to flow into Mexico; later, provisions were also made to ensure that water was not overly saline for downstream users, and several tribes have adjudicated water rights in that time as well (US Bureau of Reclamation, 2008). These agreements have been contentious to say the least, and the Colorado River has been described as having “the most complete allocation of its water resources of any river in the world and is also one of the most heavily regulated” (Christensen, Wood, Voisin,

---

23 For example, the series of court cases between Arizona and California arising out of these agreements – Arizona v. California – have “original jurisdiction” in the Supreme Court, meaning whenever a dispute arises that must be adjudicated, it goes directly to the United State Supreme Court.
Leetenmaier, & Palmer, 2004, p. 339). It has also been called the “most legislated, most debated, and most litigated river in the entire world. It also has more people, more industry, and a more significant economy dependent on it than any comparable river in the world” (Reisner, 1993, p. 120).

**Water Rights and Regulation Regimes in California and San Diego County**

Water rights in San Diego, in California, and in the American West can be inextricably complex. Water rights in San Diego County are a mix of four distinct water rights traditions:

1) Spanish water law ("Pueblo rights" in this paper), the dominant water rights regime until the Gold Rush era24
2) “Prior appropriation” laws, which were dominant beginning in the Gold Rush era
3) Riparian rights regimes, reflecting English Common Law and water law dominant in eastern US
4) Contract/preferential water rights, or the rights that function within one of these larger systems

These different water rights regimes function at multiple levels, and are often “nested.” Thus, water rights that function at the state level (e.g., prior appropriation) and the local level (e.g., riparian) may be managed by contracts at the water district level. In practice, water rights are almost all managed by contracts or agreements, such as the CRC, and many of these rights are managed at the water district level (Personal Communication, water authority representative). Water originating from both the State Water Project and the Colorado River

---

24 Up until the late 1840s, San Diego, along with all of California, was still a part of Mexico, which used the pueblo water rights system, a system which gave a municipality designated a “pueblo” a significant level of discretion and power over a river in its jurisdiction. Where these exist in the United States (only Los Angeles and San Diego have adjudicated and perfected pueblo rights in California), they are considered premiere, or highest priority, water rights.
Aqueduct are both managed by contracts at the level of the MWD, SDCWA, and local water districts (Personal Communication, water district manager).

The method of prioritizing water distribution to member agencies in the MWD has traditionally been based upon property values, which in turn were used to pay for infrastructure costs. Even though SDCWA buys more water, the preferential water rights have been based on a number of factors that tended to favor residents in the Los Angeles area. This led to bitter conflicts between Los Angeles and San Diego (or rather their proxies, MWD and SDCWA), the former tending to have higher property values, while the latter tended to have a higher need (Doe, 1993). After the MWD imposed a 20% cut to SDCWA’s urban users and a 50% cut to agricultural users in the midst of a heavy drought in 1990, the SDCWA quickly sought to create a measure of independence from the MWD (Golakoff, 2013).

In recent years, the conflict has been less about water quantity as about water cost, though the complaints are related. As recently as April 2016, SDCWA has alleged that “MWD is overcharging to transport this water and is using that money to subsidize the cost of water MWD sells to its member agencies” (“MWD Water Rate Challenge”). The SDCWA’s efforts at water independence are outlined in chapter 6.

**Agricultural Institutions and Policies**

The San Diego agricultural production system are undergirded by a set of organizations and institutions that support the economic, political, social, and human resource development of the region. The presence of policies and institutions in support of
the agricultural system is an important indicator of the extent to which the county is able to support and maintain agriculture in the region in the midst of disturbances.

**Organizational Overview**

In support of its large agricultural sector, San Diego County has a large array of agricultural institutions in close proximity to one another. This is especially true of the avocado industry, for which San Diego has been an industry hub since the first commercial avocado growers were established in the county in 1915. These organizations in or around San Diego County include county-level, state-level, and national organizations, including the San Diego County Farm Bureau (SDCFB), the California Avocado Society (CAS), San Diego County Vintners Association (SDCVA), San Diego County Flower and Plant Association, San Diego County DAWM, California Certified Organic Growers, California Cut Flower Commission, the UCCE, Mira Costa College Horticultural Department, Calavo packing houses, California Avocado Commission, the Hass Avocado Board (HAB), and many other private firms, growers, and packers. In short, San Diego County has a relatively strong organizational foundation with respect to agriculture.

**California Land Conservation Act (Williamson Act)**

An important aspect of a strong agriculture economy is access to affordable land. One way the state has sought to protect agricultural land on the urban fringe at affordable prices is through subsidized land conservation. The Williamson Act, or the California Land Conservation Act (CLCA):
Has been the premier agricultural land protection program since its enactment in 1965, preserving agricultural and open-space lands through property tax incentives and voluntary restrictive-use contracts (CDC, 2015).

The program works by private landowners voluntarily restricting their land to agricultural and compatible open-space uses under (minimum) 10-year rolling term contracts with local governments. The vast majority of these local governments are counties, but there are several cities that utilize this program as well. The “restricted parcels” are assessed for property tax purposes at a rate consistent with their agricultural or open-space use, rather than potential market value (CDC, 1992), which means the CLCA may be considered a “preferential tax program” (CDC, 1996). In any case, the local government (i.e., the county) takes on the burden of the lost property tax revenue from lower-than-market assessments, which means that there is little financial incentive for counties to undertake this kind of intervention on their own. The state has attempted to shoulder some of the burden, but has not been able to maintain the program in the budget.

According to the previous director of the CDC (CDC), the CLCA was the California Legislature’s response to a “surge of rapid population growth” in the state (CDC, 1996). Though the rate of growth has slightly decreased since the legislation was originally passed, California’s growth rate is still higher than the average national growth rate (1.04% and 0.82% per year, respectively), and the total population is now almost 10 million people larger than when the director originally wrote that statement (“U.S. Population by State, 1790 to 2015,” 2015). This is to say that the initial concerns that drove the drafting of this legislation are still very much a concern today.
Though this analysis concentrates on CLCA, it is pertinent to note that there are several other complementary farmland conservation programs in place in California. For example, Farmland Security Zones exist under more or less the same guiding framework as the CLCA, albeit with significant differences (e.g., 20-year minimum contracts, re-zoning of the parcel, and 65% property tax decrease from CLCA lands). The latest estimates put about 1 million acres of farmland in a Farmland Security Zone, while about 15.4 million acres are under CLCA contracts statewide (CDC, 2015). In San Diego County, both types of lands are regulated by the same policy titled “Agricultural Preserves” (Agricultural Preserves, 1968).

Another key complementary piece of legislation supporting the CLCA at the state level is the Open Space Subvention Act of 1971. This act set aside state money to assist local governments in recouping the expected property tax lost from assessing land on its agricultural use. Ostensibly, this was passed to make the program more attractive to local governments, and the data seems to confirm this, especially in San Diego. Though statewide data with respect to enrollment of land in the CLCA can only be estimated based on retroactive reporting before 1990 (when mandatory reporting became law) the first status report on the CLCA lands in 1992 states that “total enrollment increased dramatically through the 1970s reaching a plateau by 1980” (CDC, 1992). It is likely that this increase was due to the fact that state money was being made available to local governments for their land conservation efforts in 1971. However, in the 2009 California state budget, the legislature suspended local subventions due to budget constraints. Whereas the state had been averaging about $23.3 million dollars in subventions per year from 1972-2008, in 2009 the total subvention payments from the state dropped to $1,000; after 2009, there were no subvention
payments made at all (Mannion & Konovaloff). This has had less effect than might have been anticipated in San Diego, but CLCA acreage has still declined in recent years.

**The Free Trade Movement**

The North American Free Trade Agreement (NAFTA) has been both hailed and disparaged for its economic outcomes in Canada, Mexico, and the United States (Bhagwati, 1994). Regardless of one’s view of free trade, international trade agreements—and free trade and “regionalism” generally—have been on the rise since early 1990s (World Trade Organization). With respect to avocados, the United States avocado market has gradually been opening to foreign imports since a ban in 1985, when a few stipulations were lifted on a 1914 ban that sought to protect farmers in California from pests found in Mexican avocados (Groves & Sheridan, 1997). At that time, an avocado import regulation was passed, enabling certain varieties of avocados to be imported into the United States if they were able to meet a high grade (50 FR § 944.28). In 1993, Mexican avocados were allowed to be imported into certain markets, such as Alaska (Groves & Sheridan, 1997). Discussion began in the California legislature as early as 1994—less than a year after NAFTA was passed—concerning pest quarantine with respect to the rising likelihood that avocados would be allowed to imported into the United States, specifically into California. This bill was introduced less than a month after the government of Mexico made a request to the U.S. Animal Health Inspection Service in November of 1994 to allow the importation of fresh Hass avocado fruit grown in Michoacán, Mexico into certain areas of the United States (Costa, 1995).
The fear this sparked in the industry may be noted by the distinctive focus in the 1994 California Avocado Society Yearbook—an annual publication of articles about the avocado industry in California and around the world—on the importation of avocados from various origins, primarily Mexico and Central and South America. One article summarized a hearing by the USDA “of major importance to the avocado industry of the United States” that was convened in San Diego in November of 1994 “for the purpose of receiving comments from the public regarding requests from the Mexican avocado industry for permission to enter the United States market” (Rose, 1994, p. 39).

In January of 1997, the USDA announced that it was lifting the ban on Hass avocados into the United States from Mexico (Groves & Sheridan, 1997). This met some resistance from growers in San Diego county and elsewhere, who were ostensibly concerned with pests being imported from Mexico. These and other concerns may best be summed up by remarks made at a public hearing for the USDA by then-vice president of the California Avocado Society, Larry Rose:

The small, inaccessible areas and niches [where] avocados are grown—oftentimes commingled with suburban and even urban areas—make it virtually impossible to conduct standard pest control operations. In the last few years we've been severely challenged ... with a pest that has migrated from Mexico, the Persea mite...We're afraid that the evidence that Mexico has presented is scientifically flawed... We are afraid that the regulations that may be proposed will be unenforceable... Growers are afraid, too, that ... in spite of the best designed and best laid out regulatory plans, the real market forces will determine where fruit ends up...What growers are afraid of is that scientific method has been fabricated to prove needed conclusions...
California [avocado] growers are afraid that political decisions have already been made…Since the post-frost disaster of 1990, on a fateful day in Orange Cove, in the County of Fresno, with an entourage accompanied by Vice President Dan Quayle [that met with a delegation from the Mexican government], agreements were made that we can see unfolding here today. Your presence here alone demonstrates that an inordinate amount of resources are being applied to this project. (1994, p. 39)

That year, the USDA amended the section of the Code of Federal Regulations governing the importation of fresh Hass avocados from Mexico to the United States, allowing Hass avocados from the Mexican state of Michoacán to be imported “only during the months of November, December, January, and February in the District of Columbia and…19 northeastern States”25 (USDA, 2001).

In September 1999, the Government of Mexico requested to further expand the importation of Hass avocados into the United States under provisions set forth in NAFTA. This proposed change would include increasing the area of distribution to an additional 12 northern states,26 and extending the time period for shipment by an additional 2 months. This was approved in 2001 (USDA, 2001).

During that time, in 2000, the Hass Avocado Promotion, Research, and Information Act of 2000 (HAPRI) was passed by the U.S. Congress. Among other actions, this act

25 These states were Connecticut, Delaware, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin

26 These new “northern” states included Colorado, Idaho, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Utah, and Wyoming
established the HAB (Hass Avocado Promotion, Research, and Information Act 7 CFR §7804, 2001). The HAB is an agriculture promotion group established “to promote the consumption of Hass Avocados in the United States…[through] promotion, research and information programs under supervision of the USDA” (“About - Hass Avocado Board”).

The final important addition to the set of laws governing avocado imports is a federal regulation titled “Hass Avocados from Michoacán Mexico.” This regulation, passed in July of 2007 states:

Fresh Hass variety avocados (*Persea americana*) may be imported from Michoacán, Mexico…into and distributed in all States and in Puerto Rico 7 CFR §319.56-30 (2007)

Though many conditions remained—including safeguards against pests—the timing restrictions were lifted, and power was given to the Mexican Hass Avocado Importers Association (MHAIA) to ensure that importers conformed to these regulations.27

Needless to say, there was much fear among San Diego County avocado growers about the gradual entrée of Mexican avocados into the U.S. market, and its effects on avocado agriculture in San Diego County. The first Annual Report for HAB, for example, sought to address the concerns related to importation of avocados from Michoacán, speaking sternly on “the real possibility of oversupply of Hass Avocados in the U.S. market” (Obregon, 2010, p. 75). As one informant for this study put it:

27 The MHAIA works with the HAB in the United States for import information, marketing, and regulation. The MHAIA is also the organization that has formed the now-famous brand “Avocados from Mexico”
The decision by the federal government to modify and change the regulations governing the import of avocados was a statement by the federal government that free trade trumps protection of domestic agriculture (Personal Communication, industry representative).

This same informant went on to say, however, that the imports of Mexican avocados increased familiarity with the fruit in locations where there was little (in this example, Tennessee), and stabilized price and availability throughout the year:

With run-of-the mill [person] in Tennessee, for example, nobody knew what it was. When they were offered it, they would bite into it skin and all, I mean they had no concept of how do you eat an avocado. That’s changed over the last generation, and in large part because Mexico, and—this is a critical point—the import of Mexican avocados made avocados affordable throughout the year. Up until that time...supply of avocados in the United States was dependent upon the crop cycle in California...So we could supply commercial-quality avocados from February through October, and the peak supply was during June, July...Well, with the addition of Mexican avocados, you have basically a very stable price throughout the year. So there was a certain level of complementary dynamic going on to make that work. As much as we didn’t want the competition, we found that there were some distinct advantages to having Mexico in the mix. (Personal Communication, industry representative)
Conclusion

The historical and social-institutional development of San Diego County creates a unique study context with important nuances to be considered. The various institutional and policy structures that influence agriculture and urban development in the county are important drivers of the agricultural production system, but are insufficient in analyzing the drivers of the system in the county. In addition to the socioeconomic institutions, environmental factors are important in shaping the agricultural production system in San Diego County.
Chapter 3
The Avocado in San Diego: Biophysical & Environmental Considerations

"The growing of avocados is a highly specialized business, requiring and rewarding a greater degree of intelligence on the part of the grower...I am convinced that successful avocado culture calls for a sounder judgment, a deeper knowledge, greater skill and care than any other orchard proposition in the world...The satisfaction of working at such an occupation is correspondingly great."

-Orange I. Clark, first commercial avocado grove manager in San Diego County
(Source: California Avocado Association 1927 Yearbook, Vol. 12)

Overview of Agriculture in San Diego County

Agricultural overview

The agricultural economy in San Diego County is diversified in the extreme. According to the most recent estimates from the San Diego County DAWM Annual Crop Statistics Report, there are over 200 agricultural commodities produced in San Diego County on over 5,700 farms, the most of any county in the nation (2014). It also has more small farms (less than 10 acres) than any other county in the nation, with 3,898 (USDA, 2012; San Diego County DAWM, 2014). San Diego County is a leader in the nation in a number of crop-production categories, including avocados and tomatoes (#1 in the nation—vine-ripe tomatoes); guavas, limes, pomegranates and macadamias (#2 in the nation); honey (#3); lemons (#5); strawberries (#9); and eggs (#10) (San Diego County Farm Bureau, 2014).

According to the County of San Diego Crop Statistics and Annual Report (2014), the most important food crop in San Diego County is the avocado, with about 83,400 tons produced and a crop production value of $170 million on average for the past three years. Avocados are the most widely grown crop in the county by acreage as well, with about
20,600 acres (County of San Diego DAWM, 2014). San Diego County has a high proportion of organic growers, with about 5.5% of its farms having USDA organic certification. About 3,863 acres of avocados are grown organically, representing 21% of the avocado acreage in San Diego County (USDA, 2012).

San Diego County is considered to be “the avocado capital of the nation.” Not only does it grow more avocados than any other county in the U.S., it grows about 38% of the entire nation’s crop (California Department of Food and Agriculture, 2013). The avocado is embedded in the culture of the region, and is an important part of the local cuisine.

Over the years, San Diego County has become a center for the avocado industry, even as its share of sales in the United States has decreased with increased imports from Mexico. There are many avocado packing companies, marketers, researchers, extension experts and groups, and regulatory agencies in San Diego County and neighboring Riverside County. A large percentage of the avocados that are imported into the United States are processed by packing companies in San Diego County (Personal Communication, industry representative). For this and other reasons, this analysis emphasizes avocado agriculture in the county as it seeks to understand the many factors shaping farmland conversion and the maintenance of an agricultural character in a county and region that is losing that character rapidly.
Table 3a. San Diego County agricultural overview

<table>
<thead>
<tr>
<th>Metric</th>
<th>San Diego</th>
<th>California</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres in agriculture</td>
<td>221,538</td>
<td>25,569,001</td>
<td>2,109,303</td>
</tr>
<tr>
<td># of farms</td>
<td>5,732</td>
<td>77,857</td>
<td>914,527,657</td>
</tr>
<tr>
<td>% of farms with organic status (#)</td>
<td>5.5%</td>
<td>3.6%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Average size of farm [acres]</td>
<td>39</td>
<td>328</td>
<td>434</td>
</tr>
<tr>
<td>Market value</td>
<td>$725 million ($1.8 billion*)</td>
<td>$42.6 billion</td>
<td>$394.6 Billion</td>
</tr>
<tr>
<td>% of farms &lt; 10 acres (#)</td>
<td>68%*</td>
<td>32%</td>
<td>11%</td>
</tr>
<tr>
<td># of agricultural commodities</td>
<td>&gt;200*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Principal Operator (P.O.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P.O. Primary Occupation</td>
<td>Farming: 48%</td>
<td>Farming: 55%</td>
<td>Farming: 48%</td>
</tr>
<tr>
<td></td>
<td>Other: 52%</td>
<td>Other: 45%</td>
<td>Other: 52%</td>
</tr>
<tr>
<td>Average age of P.O.</td>
<td>62.3</td>
<td>60.1</td>
<td>58.3</td>
</tr>
<tr>
<td>P.O. by sex</td>
<td>Male: 81%;</td>
<td>Male: 85%;</td>
<td>Male: 86%;</td>
</tr>
<tr>
<td></td>
<td>Female: 19%</td>
<td>Female: 15%</td>
<td>Female: 14%</td>
</tr>
<tr>
<td>Avocados</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acres in Avocados</td>
<td>20,506</td>
<td>59,814</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(18,439*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acres in organic avocados</td>
<td>3,863</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td># of farms growing avocados</td>
<td>2,778</td>
<td>5,602</td>
<td>-</td>
</tr>
<tr>
<td>% of farmland in avocados</td>
<td>6.9%</td>
<td>0.2%</td>
<td>-</td>
</tr>
<tr>
<td>Production value of avocados</td>
<td>$154 million*‡</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

‡Value measured by DAWM is Total Value of Production, which measures the value of all the inputs of a product, not the market price.
Avocados in San Diego County

The oldest avocado tree in San Diego County is said to have been planted “on the ranch of W.W. Prior in Escondido in about 1895. The next tree on record was planted in 1911 in El Cajon Valley” (“First Avocados Grown in Encinitas, 1920,” 1950; Popenoe, 1927, p. 41). The most significant year in the early days of avocado growing in San Diego County was 1915, when orchards were planted simultaneously in Encinitas, Chula Vista, Carlsbad, Vista, Lemon Grove, and Point Loma. The most important of these was the Point Loma planting, which was a small commercial planting of avocados set out at the Theosophical Headquarters run by Madame Katherine Tingley on Point Loma (Popenoe, 1927, p. 42). For decades, the grove at Point Loma was considered to be the premier avocado research grove in San Diego County.
For the first few decades following 1915, however, the range of avocados was fairly wide in San Diego County, with groves growing in the southern, eastern, coastal, and northern sections of the county (Popenoe, 1927). In these locations, a diverse array of varieties was grown, including Fuerte, Anaheim, Puebla, Harmon, Taft, and a long list of others (Popenoe, 1927; “First Avocados Grown in Encinitas, 1920,” 1950). By the late 1920s, the Fuerte had become the most prominent variety in San Diego. Though the Hass variety of avocado had been developed (by accident) in the 1920s, it did not gain prominence until a decade or so later (“The Hass Mother Tree,” 1973). However, even by 1975, Fuerte was still the most prominent variety in San Diego County, with Hass at a close second (Table 3b).

Table 3b. Varieties of avocados grown in San Diego County, 1975

<table>
<thead>
<tr>
<th>Variety</th>
<th>Acres</th>
<th>% of Total Avocado Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuerte</td>
<td>8,124</td>
<td>44%</td>
</tr>
<tr>
<td>Hass</td>
<td>7,243</td>
<td>39%</td>
</tr>
<tr>
<td>Zutano</td>
<td>1,160</td>
<td>6.3%</td>
</tr>
<tr>
<td>Bacon</td>
<td>902</td>
<td>4.9%</td>
</tr>
<tr>
<td>All Others</td>
<td>1,034</td>
<td>5.6%</td>
</tr>
</tbody>
</table>


The popularity of Hass continued to grow, and by 2006, Hass represented about 93% of avocados grown in San Diego County, and the DAWM had stopped tracking Fuerte avocados as a separate variety, since they had represented only 1.5% of the county’s acreage in avocados the year prior and continued to decline in importance (County of San Diego DAWM, 2006). As of the most recent count, Hass represents over 94% of the varieties grown
and Lamb-Hass represents about 4.1%, with various other varieties representing the remaining 1.9% of avocados (County of San Diego DAWM, 2014).

Avocado Ecophysiology

Overview, History, and Evolution

The avocado is a tree fruit in the Lauraceae family, a family of “mostly trees and shrubs” (Schaffer, Wolstenholme, & Whiley, 2012, p. 1). A native to the montane rainforests of Central America, the avocado—or the *Persea americana*—is considered to be the most important commodity from the Lauraceae family (Chanderbali, Soltis, Soltis, & Wolstenholme, 2012, p. 31). Because of the avocado’s origin in a wet subtropical environment with thick organic mulch, the avocado root system is “invariably described as relatively shallow” (Chanderbali, Soltis, Soltis, & Wolstenholme, 2012, p. 40).

The avocado is considered to be relatively “primitive” or “basal” angiosperm, and has been called a “ghost of evolution” in popular literature, meaning that it is surmised to have co-evolved with now-extinct large American ground sloths (Heywood, 1993; Barlow & Martin, 2002). These large land mammals would eat the fruit whole, allowing the slippery seeds to pass through their stomachs, after which the avocado seed—still intact—would be deposited in a fertile pile of dung. There are no longer large enough megafauna in the Americas to accomplish this, but as the avocado has spread to other parts of the world, elephants have been reported to carry out this same function (Tchamba & Seme, 1993).

There are generally considered to be three “races” of avocados: Mexican, Guatemalan, and West-Indian. The Mexican and Guatemalan races are considered to be subtropical, while the West Indian race is adapted to grow in tropical conditions. In the United
States, the first two are grown extensively in California (as well as in Mexico and Central America), while the latter is grown in places like Florida and Hawaii (Schaffer, Wolstenholme, & Whiley, 2012). The Hass avocado is a hybrid cross between the Mexican and Guatemalan races, possessing traits characteristic to each.

**Domestication, Orcharding, and Flowering**

The avocado in general and the Hass avocado in particular is a “relatively new crop and only semi-domesticated” (Schaffer, Wolstenholme, & Whiley, 2012, p. 5). As noted above, avocados in San Diego have only been subject to research and domestication trials for about one century. There are many variations of planting layouts and orcharding techniques, and there many ongoing experiments to improve these techniques (Personal Communication, extension advisor). The arrangement may also change over the life-course of a tree, as seedlings and graftings need not be spaced as widely as mature trees (Platt, 1976). One common arrangement is a 20’ x 20’ spacing (20’ from the center of one tree to the next), that the growers will thin out when the trees get large and begin to shade one another out (“A Planting Plan for Avocados”). By the time the orchard has matured, there will be about 100 trees per acre. The 20’ x 20’ spacing is only one of many possible orchard layout, and there are trials currently underway in San Diego County to assess the utility of “dense planting,” which—as the name suggests—is a way of planting avocado trees in which the trees are spaced more closely to one another, and more extensive pruning is required (Personal Communication, extension advisor).

Avocados exhibit a rare form of flowering described as “complementary, synchronous dichogamy.” Avocado varieties are classified into two types based on their
flowering behavior: A-type and B-Type. For both types, the flower opens twice for several hours each time and the two openings are separated by at least one overnight period. During each of these openings, a flower is functionally either female or male—never both at the same time. For A-type cultivars (or “Group A”), the flower’s first opening starts in the morning and ends before noon, and it is functionally pistillate (female); the second opening (male) occurs in the afternoon of the following day. B-Type cultivars exhibit the reverse pattern: the female opening occurs in the afternoon, with the male opening occurring the next morning (Lahav & Lavi, 2012). There is often overlap of these openings on the same tree or in an orchard, so monoculture orchards are able to reproduce. However, environmental conditions have a substantial effect on the overlap of functionally male and female flowers, and may affect the ability of a monoculture orchard to reproduce (Lahav & Lavi, 2012).

Avocados trees, especially the Hass variety, are also prone to alternate bearing cycles, “repeating cycles of a light low yield ‘off’ crop...followed by heavy, high yield ‘on’ crop (Salazar-Garcia, Garner, & Lovatt, 2012, p. 146). This point, along with the previous point that avocados are best able to reproduce with A-Type and B-Type cultivars present, is why many people advocate for more varieties being produced and marketed. However, there currently is no large market for varieties outside of Hass, which pushes farmers to maintain one variety in their orchards (Personal communication, extension advisor).

**Temperature**

The effects of temperature on avocado growth and development differ among varieties. The two temperature parameters that are important for avocados to grow in a given climate are: high temperature and low temperature. Because the portion of San Diego County
west of the coastal ranges has a relatively mild climate, high temperature is rarely an issue. Very close to the coast, low temperatures and frost tend not to be an important concern for avocados. Where much of the avocado growing currently is happening—in the foothills of the coastal ranges of northern San Diego County—temperatures often dip dangerously close to the minimum temperatures that most varieties can handle (Figure 3b). The Hass avocado—and A-Type avocados in general—tend to have a greater tolerance to high and low temperatures than B-Type cultivars, but there are only a few degrees separating the average minimum air temperature in the winter, and the minimum temperature hass avocados are able to withstand (Schaffer, Gil, Mickelbart, & Whiley, 2012).

**Figure 3b.** Average monthly maximum and minimum temperature at Escondido CIMIS Weather Station, 1999-2015

![Average Monthly Air Temperature](image)

Source: California Irrigation Management System (CIMIS)

**Biophysical Context of San Diego County**

The biophysical peculiarity of San Diego County has been a boon to farmers, horticulturists, botanists, and the everyday tourist for over a century. Because of its
relatively moderate temperatures that tend to stay near or above freezing, it is able to support avocados and many other sub-tropical crops. Much of San Diego County is characterized by a USDA hardiness zone of 10a/b, and some of the region even reaches a hardiness zone of 11 (less than 10 counties in the contiguous United States have a hardiness zone of 11) (USDA, 2012). Hardiness zones are determined based on the average annual extreme minimum temperature in a given location. A hardiness zone of 11 has an average annual extreme minimum temperature of 40°F; 10b, 35°F; and 10a, 30°F. Hass avocados can survive up to four hours at temperatures as low as 26°F, depending on conditions. Close to the coasts, avocados and other crops have the benefit of more stable temperatures and periodic fog cover, which reduces ET₀. However, most crops in San Diego County are grown further inland.

**Geography of Avocado Agriculture**

The vast majority of agriculture—and specifically avocado agriculture—in San Diego county takes place in the northern half of the county, in the foothills just south of the Santa Ana Mountain Range and just West of the Cuyamaca Mountain Range (Figure 3c). This is the area on which this analysis focuses in framing the biophysical constraints and opportunities that exist for agriculture—with a focus on avocados—in San Diego County.
Most of the avocado agriculture in San Diego County takes place in five water districts, each of which is a member of the SDCWA: Valley Center Municipal Water District (Valley Center MWD), Yuima Municipal Water District (Yuima MWD), the Rainbow Municipal Water District (Rainbow MWD), the Ramona Municipal Water District (Ramona MWD) and the Fallbrook Public Utilities District (Fallbrook PUD) (SANGIS). The policies and rates in these few districts have a great bearing on the viability of agriculture in the entire county.

Local Evapotranspiration, Precipitation and Water Resources: Escondido

The concept of evapotranspiration is important for any farmer, and especially for those in semi-arid contexts, because it can help them determine the amount of water that a given crop is likely to need. If rain is imminent, irrigation may not be necessary. In the
absence of precipitation, however, irrigation must be used to replenish the water lost to evapotranspiration.

The average avocado farmer in San Diego County has about 7.4 acres of avocados in production. One study by the UCCE has calculated the crop coefficient ($K_C$) with respect to the potential evapotranspiration (ET) of mature Hass avocado trees to be about 0.64\textsuperscript{28} (Grismer, Snyder, & Faber, 2000). This analysis provides an estimate based on the most recent CIMIS data in the past decade and a half. The results are shown in Table 3c where:

$$ET_C = ET_0 \times K_C$$

$ET_0$ is reference crop evapotranspiration and $ET_C$ is crop evapotranspiration for avocados. $K_C$ is a crop coefficient, different for various crops. $ET_C$ is a useful metric for providing a rough estimate of the crop water requirement for a given crop in a specific environment. Table 3c provides this equation for a mature avocado grove given the average ET rates near Escondido, CA from 1999-2015.

The values in Table 3c represent the total water requirement of an average-sized avocado orchard in San Diego County. In a given year, rainfall may provide much of that water. The average annual rainfall at the Escondido CIMIS station over the past fifteen years has been about 8.27 inches per year (Table 3d).

---

\textsuperscript{28} This may be a relatively low estimate, as $K_C$ may vary between 0.5 and 0.75 and many calculations use 0.7, depending on soil and atmospheric conditions.
### Table 3c. Estimated water requirements for an example mature avocado orchard near Escondido, CA, 1999-2015

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Days</td>
<td>Inches</td>
<td>Gallons</td>
<td>Gallons</td>
<td>Per acre per month (109 trees/acre)</td>
<td>Per tree, inc. 10% leaching &amp; 0.8 distribution uniformity</td>
</tr>
<tr>
<td>Jan</td>
<td>0.08</td>
<td>0.64</td>
<td>0.049</td>
<td>16.92</td>
<td>57,163</td>
<td>423,009</td>
</tr>
<tr>
<td>Feb</td>
<td>0.10</td>
<td>0.64</td>
<td>0.062</td>
<td>21.20</td>
<td>65,295</td>
<td>483,186</td>
</tr>
<tr>
<td>Mar</td>
<td>0.13</td>
<td>0.64</td>
<td>0.082</td>
<td>28.10</td>
<td>94,953</td>
<td>702,655</td>
</tr>
<tr>
<td>Apr</td>
<td>0.17</td>
<td>0.64</td>
<td>0.106</td>
<td>36.21</td>
<td>118,392</td>
<td>876,106</td>
</tr>
<tr>
<td>May</td>
<td>0.19</td>
<td>0.64</td>
<td>0.124</td>
<td>42.61</td>
<td>143,984</td>
<td>1,065,486</td>
</tr>
<tr>
<td>Jun</td>
<td>0.22</td>
<td>0.64</td>
<td>0.142</td>
<td>48.64</td>
<td>159,052</td>
<td>1,176,991</td>
</tr>
<tr>
<td>Jul</td>
<td>0.23</td>
<td>0.64</td>
<td>0.145</td>
<td>49.69</td>
<td>167,902</td>
<td>1,242,477</td>
</tr>
<tr>
<td>Aug</td>
<td>0.21</td>
<td>0.64</td>
<td>0.137</td>
<td>46.93</td>
<td>158,574</td>
<td>1,173,451</td>
</tr>
<tr>
<td>Sep</td>
<td>0.18</td>
<td>0.64</td>
<td>0.112</td>
<td>38.47</td>
<td>125,807</td>
<td>930,973</td>
</tr>
<tr>
<td>Oct</td>
<td>0.12</td>
<td>0.64</td>
<td>0.078</td>
<td>26.69</td>
<td>90,169</td>
<td>667,256</td>
</tr>
<tr>
<td>Nov</td>
<td>0.09</td>
<td>0.64</td>
<td>0.058</td>
<td>19.82</td>
<td>64,817</td>
<td>479,646</td>
</tr>
<tr>
<td>Dec</td>
<td>0.07</td>
<td>0.64</td>
<td>0.044</td>
<td>15.15</td>
<td>51,183</td>
<td>378,761</td>
</tr>
</tbody>
</table>

**Annual Total**
- **Gallons**: 1,297,296
- **Inches**: 47.8

### Table 3d. Average annual rainfall near Escondido, CA, 1999-2015

<table>
<thead>
<tr>
<th>Avg. Precipitation</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches (in)</td>
<td>1.00</td>
<td>2.23</td>
<td>1.16</td>
<td>0.85</td>
<td>0.20</td>
<td>0.01</td>
<td>0.02</td>
<td>0.07</td>
<td>0.04</td>
<td>0.87</td>
<td>0.75</td>
<td>1.08</td>
<td><strong>8.27</strong></td>
</tr>
<tr>
<td>Millimeters (mm)</td>
<td>25.4</td>
<td>56.5</td>
<td>29.5</td>
<td>21.7</td>
<td>5.0</td>
<td>0.3</td>
<td>0.5</td>
<td>1.8</td>
<td>0.9</td>
<td>22.1</td>
<td>19.0</td>
<td>27.3</td>
<td><strong>210</strong></td>
</tr>
</tbody>
</table>

CIMIS estimates that the average annual depth of rainfall near Escondido, CA is 8.27 inches. This amount of rain over an entire acre is about 225,000 gallons of water per acre per year. For the average avocado grower in San Diego County with 7.4 acres, an average of 1,660,000 gallons of water, or 5.1 acre-feet, is provided by rain for their grove every year. This is 17.3% of the 29.5 acre-feet value calculated above, leaving about 24.4 acre-feet to be provided by alternative sources.\textsuperscript{29}

In terms of alternative water sources that may be available to avocado growers, this is also highly variable depending on location. Most of San Diego County has few groundwater resources, but certain areas, such as Pauma Valley, have enough groundwater where wells may be economically feasible, even if they still are not able to provide all the water needed (Personal communication, water district manager).

This geographic variability is further highlighted when comparing the ET\textsubscript{0} values in two locations within San Diego County. Escondido—near where much of the agricultural output in the county is centered—has much higher ET\textsubscript{0} values than at Torrey Pines, which is at more or less the same latitude, but along the coast (Figure 3d). In the early days of agriculture in San Diego County, many avocados were grown along the coast, and enjoyed the favorable ET conditions there. However, as land values along the coast have risen rapidly and people built homes there, agriculture has been forced onto more marginal lands inland.

\textsuperscript{29} Of course, these estimates are quite rough and do not take into account seasonality of rainfall and the different water needs of avocado trees at different life stages and in different parts of the season as rainfall, ET\textsubscript{0}, temperature, and cloud-cover are dependent on a number of factors, including which side of the hill a grove is growing on, or high above a valley the avocados might be planted.
Topography and Management Implications

As demonstrated previously, avocados are grown on relatively small plots and often on steep hillsides. The former vice president of the California Avocado Society explained avocado agriculture in San Diego and surrounding counties as follows:

Avocado acreage is not farmed in large contiguous sections as many other commodities and crops are nationwide; it adapts itself to canyons and ridge tops and geography that isolates itself to frost-free areas along a strip within California.

(Rose, 1994)

In addition to the difficulties marginal land creates for pest control, harvesting, and other key elements of agriculture in the region, an important consideration for growing avocados in San Diego County is temperature. However, temperatures and ranges vary greatly across the county, from the moderate climate along the Pacific coast, to the high extremes in the endorheic Salton Sink. In the middle of these extremes are the foothills and
mountain valleys where much of the avocado production industry is located, and here the temperature is highly variable. A grove’s location is important, whether it is on the leeward or windward side of a mountain; on an east-, south-, north-, or west-facing slope; or in a river valley or near a hilltop: all of these (and other factors) affect ET rates, photosynthesis rates, the amount of rainfall received, and the manner in which crops must be harvested (Personal Communication, extension advisor). That is to say, these factors are extremely local.

One phenomenon that is especially important for avocado growers is the warming of mountain slopes occurring from so-called “valley winds.” This is also called a “cold air drainage inversion,” in which denser, cold air settles on the valley floors (“Weather Fundamentals”; “Chapter 4: Insolation and Temperature”). Because of this phenomenon, many avocado groves are unable to survive on valley floors during the winter, when the cold air causes frosts to accumulate (Personal Communication, extension advisor). Thus, many avocado groves in San Diego County can be found wrapping up onto hillsides, where the temperature is a degree or two warmer, a substantial difference when the margin between crops freezing and surviving is often very thin in the winter (Rose, 1994).

Although the yearly temperature ranges in San Diego are ideal for most agriculture, there are many difficulties (besides water) that must be overcome for a farmer of any stripe to be successful and profitable there.

Conclusion

This chapter has provided the biogeophysical and environmental context for agricultural in San Diego California, specifically avocado agriculture. Environmental factors drive and shape the agricultural production system in San Diego County. The effects of these
factors include avocados being grown on more marginal lands with thinner soils and lower values. It also makes cultivation, harvesting and growing an increasingly difficult task, and has led to interesting innovations over the years, including monorails crisscrossing slopes between rows of avocados, and llamas being used as pack-animals. From one perspective, it also has provided avocado orchards with a very small measure of security, as the lands on which orchards are currently growing are less prone to development pressures (Personal Communication, industry representative).
Chapter 4
The Problem Context: Local, Regional, and National Trends

“We are seeing an upward pressure on costs, downward pressure on revenue. Farmers are trying denser plantings, salt tolerant root stocks, root rot resistant root stock, drip irrigation— all this is good, but it has not been determined if these new techniques can overcome the change in basic economics.”

-Avocado Grower, San Diego County

Introduction

The previous chapters have provided useful context for understanding and exploring the context of San Diego County with respect to the institutions, processes, and historical developments that have led to the current agriculture production system. This chapter lays out the significant trends affecting agriculture in the past 10-30 years. The emphasis of these particular themes and trends draws upon informant interviews and survey responses by avocado growers in San Diego County; secondary data has been utilized to better understand the nature of these trends, and the likely effects they will have on San Diego. After introducing these local perspectives, this chapter begins exploring a trend that growers have given only nominal acknowledgement, but which data and literature suggest are significant in terms of agriculture land conversion: increasing land values. It then moves on to address water and availability and affordability, or the lack thereof. After that, there is a section on the avocado market in the United States. Finally, there is a section on the trends surrounding policy and economics in the region.
Local Perspectives: Survey Results

Towards the completion of a mixed-methods, transdisciplinary analysis, a grower survey was designed to capture the sentiments and concerns of growers in the region. Surveys were distributed online to growers in the county via channels that were likely to reach agricultural producers and which had a high likelihood of reaching avocado growers. The survey correspondence and questionnaire informed potential respondents that avocado growers were the intended participants, though a few non-avocado growers completed the survey as well. Fifty people opened the survey, but only 29 completed the entire survey. Of these, 26 were currently growing avocados, or had been in the past decade. In order to maintain a homogenous sample population, the data from these 26 respondents is what has been used in this analysis. A copy of the survey instrument is included in Appendix I.

As a comparison for potential self-selection bias, demographic information for the survey respondents was collected and is displayed in Table 4a. The demographics of survey respondents are fairly consistent with the demographic characteristics of operators in the county as a whole, according to the USDA Census of Agriculture. The size of the avocado orchards managed by respondents were the same size as the average avocado orchard in the county; the size of farms in general were much smaller in the survey population than the target population.
Table 4a. Demographics of survey respondents

<table>
<thead>
<tr>
<th>Demographic Parameter</th>
<th>Survey</th>
<th>USDA Census of Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Age of Operator (n=21)</td>
<td>60.3</td>
<td>62.3</td>
</tr>
<tr>
<td>Gender of Operator (n=22)</td>
<td>Male: 85%</td>
<td>Male: 81%</td>
</tr>
<tr>
<td></td>
<td>Female: 15%</td>
<td>Female: 19%</td>
</tr>
<tr>
<td>Principal Operators by Primary Occupation (n=26)</td>
<td>Farming: 31%</td>
<td>Farming: 48%</td>
</tr>
<tr>
<td></td>
<td>Other: 69%</td>
<td>Other: 52%</td>
</tr>
<tr>
<td>Average size of avocado orchard (n = 21) [acres]</td>
<td>7.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Average size of entire farm (n=24) [acres]</td>
<td>30.4</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 4b. Important themes in survey responses

<table>
<thead>
<tr>
<th>Question</th>
<th>Survey Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you significantly reduced the amount of land dedicated to avocados in the past decade or so? (n = 24)</td>
<td>Yes: 42% (about 8% stopped growing avocados altogether) No: 58%</td>
</tr>
</tbody>
</table>
| What significant management changes have you made to your farm or orchard in the past decade or so? (n = 20; answers listed in order of importance) | 1. Updated Irrigation System  
2. Hired less labor  
3. Planted/Pruned Trees Differently  
4. Changed land use of part of farm/orchard away from agriculture (or sold to someone who did)  
5. Changed Pest Management Strategy  
6. Changed crop  
7. Switched to organic |
| What is the greatest challenge you face in maintaining a viable farm? (n = 26; answers listed in order of importance) | 1. High Price of Water  
2. Drought or lack of water  
3. Competition from Mexico  
4. Poor Quality of Water  
5. Low Market Prices for product  
6. Policies and/or Regulations  
7. Labor Costs |
| What is your greatest concern with respect to the profitability/viability of your farm or orchard in the…: (n = 23; answers listed in order of importance) | **Short-term (1-5 yrs)**  
1. Water costs  
2. Foreign competition  
3. Regulation  
4. Drought/Climate  
5. Labor  
6. Small profit margin  
7. Water supply  
**Medium-term (5-10 yrs)**  
1. Water costs  
2. Regulation  
3. Foreign competition  
4. Urban encroachment/Land prices  
5. Drought/Climate  
6. Labor  
**Long-term (10+ yrs)**  
1. Water costs  
2. Aging farmers  
3. Foreign competition  
4. Urban Encroachment/Land prices  
5. Lack of adaptability  
6. Regulation  
7. Drought/Climate |
The most common theme with respect to the difficulties facing farmers in San Diego County was the cost of water. This came out as the most important topic in all categories, even in the significant management changes. This is not without reason, as water prices have more than doubled in the past decade (Table 4f). Another common theme in many of the answers was foreign competition, especially from Mexico. The increase in the imports of avocado as a result of trade liberalization leaves farmers in San Diego County feeling threatened, though some say that this is a double-edged sword—stabilizing the market, but perhaps narrowing the market for San Diego growers.

Another common theme was regulation, or as one respondent termed it, “one-size-fits-all regulation.” Regulation is a broad category, and may refer to a number of laws, policies, or rules, but informants and open-ended survey responses pinpoint two pieces of regulation in particular: water runoff regulation and water cost abatement. The avocado industry in San Diego County is relatively small and specialized in the scope of agriculture in the United States. Thus, the primary and secondary effects of certain regulations on the industry are often not fully understood for several years, or even decades after being implemented. Thus, an approach was taken to understand which regulations, policies, incentives, or programs growers felt were most important to them. The general human bias towards negativity notwithstanding, the felt effects of regulations are tangible, and may constrain the ability of farmers to make a profit. The most important policy considerations identified by growers are displayed in Table 4c.
Table 4c. Survey results: policies helping and hurting agriculture in San Diego County

In maintaining a viable farm in San Diego County, especially over the past decade, what policies, incentives, regulations, or other programs have been:

(n = 20)

<table>
<thead>
<tr>
<th>Most helpful</th>
<th># of Responses</th>
<th>Least Helpful</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAWR/Local water cost abatement</td>
<td>6</td>
<td>6 High water prices, No water cost abatement</td>
</tr>
<tr>
<td>“Nothing”</td>
<td>5</td>
<td>6 Water quality regulation</td>
</tr>
<tr>
<td>Water Recycling</td>
<td>3</td>
<td>4 Government regulation</td>
</tr>
<tr>
<td>Grants (USDA)</td>
<td>3</td>
<td>3 Lack of water/Rationing of water</td>
</tr>
<tr>
<td>Water Storage/Conservation</td>
<td>2</td>
<td>1 Organic Certification is costly</td>
</tr>
<tr>
<td>UC Cooperative Extension</td>
<td>2</td>
<td>1 Marijuana illegal</td>
</tr>
<tr>
<td>Boutique winery Ordinance</td>
<td>1</td>
<td>1 Bureaucracy</td>
</tr>
<tr>
<td>Water management (SDCWA &amp; County)</td>
<td>1</td>
<td>1 Better water management needed at state level</td>
</tr>
<tr>
<td>Water Audits</td>
<td>1</td>
<td>1 Pests associated with imports</td>
</tr>
<tr>
<td>Energy Conservation</td>
<td>1</td>
<td>1 San Diego County Dept. of Fish and Game</td>
</tr>
<tr>
<td>Reduction of Permitting/Regulation</td>
<td>1</td>
<td>1 Taxes</td>
</tr>
<tr>
<td>Right to farm</td>
<td>1</td>
<td>1 Pesticide regulation</td>
</tr>
<tr>
<td>Strong Market Demand</td>
<td>1</td>
<td>1 Labor laws</td>
</tr>
</tbody>
</table>

Once again, the importance of water is highlighted by these answers, with water regulations and policies topping both lists. Efforts made by the SDCWA, UCCE, and the federal government (e.g., USDA) are highlighted as important for maintaining farm viability. High water prices, water quality regulation, general regulatory frameworks, bureaucracy, and lack of effective water management (particularly at the state level) are all identified as important concerns in the policy and regulatory framework of the county agricultural production system.

Growers understandably feel that “one-size-fits-all regulation” is not grounded in their reality of working under thin profit margins with unfriendly trends on all sides. As one grower said in a statement that reflects the general sentiment of many of the growers surveyed: “we don't live in an economic vacuum but our elected seem to think that we do.”

Finally, urban encroachment and land prices are recognized as being medium- and long-term concerns, and many respondents have already changed part of their land use away
from agriculture. Though the topic of land values is not often given the most attention in San Diego County due to the acuteness of the water shortages, this topic is often given most attention and credence in planning and farmland preservation dialogue.

**Land Values and Land Use**

**California**

Development pressure has been a driving force for urban development in California at least since it became a part of the United States in 1848. In recent years, these pressures have increased dramatically. According to the CDC’s Farmland Mapping and Monitoring Program (FMMP), since 1984, the state as a whole has lost nearly 1.4 million acres to of agricultural land (about 1 million acres of cropland and 0.4 million acres of grazing land). In the same period, the amount of urban and built-up land has increased by about 1.1 million acres, an increase of about 42.8% of the 1984 urbanized area. This is in part because of the disproportionately large increase in population California experienced in that period (CDC, 2014). From 1990 to 2010, the population of California increased by about 7.5 million, an amount greater than the total 2010 population of 41 states. This accounted for 12.5% of the growth in the United States in that time period (“U.S. Population by State, 1790 to 2015”).

**San Diego County**

The story of San Diego County with respect to urban development and agricultural land conversion is similar to that of California as a whole, but with more intensity. According to the FMMP, the rate that “urban and built-up” land is increasing in San Diego is about the same rate as in California as a whole, increasing between 1984 and 2010 by 40.4%.
However, the rate at which this urban development is reaching into agricultural land is far higher than the rest of the state, with agricultural land in the county decreasing by 30% of its 1984 total in that same time period. Of particular interest is the fact that two-thirds of “Farmland of Statewide Importance” in San Diego County was lost in that time period, which—as defined by the County of San Diego—is land ideal for growing citrus, field crops, and avocados (CDC, 2014).

Table 4d. Land use change by category, 1990-2010

<table>
<thead>
<tr>
<th>Land Use by Category</th>
<th>San Diego County</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990 (acres)</td>
<td>2010 (acres)</td>
</tr>
<tr>
<td>Urban &amp; Built-up Land</td>
<td>274,812</td>
<td>355,144</td>
</tr>
<tr>
<td>Important Farmland</td>
<td>98,492*</td>
<td>64,883*</td>
</tr>
<tr>
<td>Farmland of Statewide</td>
<td>15,314</td>
<td>9,440</td>
</tr>
</tbody>
</table>

*Because of the way farmland of local importance is measured has changed periodically since 1990, data is not included in this analysis.

The FMMP also reported that there is a large portion of land simply being taken out of production (i.e., not being converted to any other permanent use), especially in San Diego County (CDC, 2014). This is likely due to what some may perceive as short-term shocks—such as water restrictions—that growers hope to overcome in the long run (CDC, 2014).

In addition to the proverbial “elephant in the room” when it comes to agricultural land loss in California (i.e., the issue of accessible, affordable water), much of the state’s farmland conversion is being fueled by land economics, or high and increasing land prices. Land values in San Diego are among the highest in the nation, with an average land value of over $400,000 in 2015 (Figure 4a). Land values in San Diego are also increasing at one of the fastest rates in the nation, with a 319% increase in land values between 1984 and 2015.
(Figure 4b). Land values, along with high costs for all farm inputs (including water, labor, and other inputs), are creating an environment in which it is extremely difficult to maintain profitable farms.

**Figure 4a.** Average land value in ten largest US cities, 1984-2014

Source: Lincoln Institute for Land Policy
In one attempt to address land conversion in the state, state law-makers passed the Williamson Act in 1965 to create agriculture preserve lands in the state. The Williamson Act was introduced in chapter 2 as a “preferential tax program” in which the state or county enters into contracts with landowners with agricultural uses to assess land for taxation purposes by its agricultural use, instead of by its highest use or potential market value (CDC, 1996). This allows farmers to keep their land in agriculture without the financial pressure of money to be gained from converting to urban land uses. This appears to have had some positive effects until the early 1990s, but three likely factors have limited its effectiveness: 1) land prices have increased so much that the rewards to be gained from conversion are more substantial than they had been previously (this also increased the property tax burden, even if the rate was still artificially low); 2) water prices have increased so much in the past decade and a half that agricultural uses are spending more on these inputs than is feasible to maintain a profitable enterprise, encouraging them to find other uses for their land; and 3) the cutting off of state funds for the agricultural contracts.
As was briefly mentioned in chapter 2, in the 2009 California state budget, the legislature suspended local subventions, decreasing funding for the program from what had been over $23 million to about $1,000. After 2009, there were no subvention payments made at all, and CLCA lands in the state declined to levels not seen since at least the mid-1970s (Figure 4c) (Mannion & Konovaloff).

**Figure 4c.** Acres enrolled in the Williamson Act program in California and San Diego County, 1965-2013

![Graph showing acres enrolled in the Williamson Act program in California and San Diego County, 1965-2013.](source: California Department of Conservation)

Note on estimated data: estimated data is for that data that was unreported by the California Department of Conservation. For the period of 1968-1986, the estimated data is based on a graph (with inexact figures) from the 1992 report. Other estimated data is based on verbal description of trends, or in logical trends based on reported data.

In San Diego County, the suspension of subvention funds in 2009 appears to have had little effect on the acres of land enrolled in the CLCA. The data above suggests that another factor—land markets—are much more important in determining CLCA enrollment (Figure 4e and Table 4e). When land values experienced a dramatic increase in the county between 1996 and 2005 (Figure 4e), the amount of land enrolled in the CLCA plummeted. Whereas between the entire period reported below (1991-2013) there was an average loss of 2.43% of...
acres enrolled in the CLCA, during the period of 1996-2005 when land values increased there was an average loss of 4.67%.

As noted by Table 4e, not all the land enrolled in the CLCA in San Diego is equal, nor was the land that was lost during the period of rapidly rising land values in San Diego and other US cities (1996-2005, see Figure 4e). The NRCS categorizes land as “Prime” and “Non-Prime” based on the “best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops” and based on whether the land is already urban or built-up (“Prime Farmlands Definitions”).

**Figure 4d.** Acres enrolled in Williamson Act and land in orchards and vineyards in San Diego County

San Diego County has much more non-prime land than prime land enrolled in the CLCA, and has a much higher rate of non-prime farmland than other counties in California (Table 4e). During the entire period from 1991-2013—and especially during the period of
ris

Figure 4e. Acres enrolled in the Williamson Act and land values in San Diego MSA, 1991-1992

Sources: California Department of Conservation; Brookings Institute

When comparing San Diego to California as a whole, other salient inferences may be drawn from this data. One inference is that San Diego County tends to have higher rates than
the rest of the state in enrollment of non-prime land in the CLCA, and that during times of increasing land values in US cities, the CLCA has been better at protecting non-prime farmland than prime farmland across the state, not just in San Diego. In fact, counterintuitively, enrollment of non-prime land actually increased in the state as a whole during this time. In San Diego, both prime and non-prime acreage enrolled in CLCA decreased during this time, but prime land decreased at a disproportionately high rate.

Table 4e. Land enrolled in the CLCA, 1991-2013

<table>
<thead>
<tr>
<th></th>
<th>San Diego County</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Annual % Change in Acres Enrolled in CLCA</td>
<td>-2.4%</td>
<td>-4.7%</td>
</tr>
<tr>
<td></td>
<td>Prime Acres</td>
<td>-5.2%</td>
</tr>
<tr>
<td></td>
<td>Non-Prime Acres</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Composition of Acreage Enrolled in CLCA</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Prime Acres</td>
<td>9.2%</td>
</tr>
<tr>
<td></td>
<td>Non-Prime Acres</td>
<td>90.8%</td>
</tr>
</tbody>
</table>

Source: Data was aggregated from bi-annual Williamson Act (CLCA) status reports from 1990-2014 published by the CDC

One possible reason that San Diego has such a high rate of enrollment of non-prime lands is the kind of agriculture primarily done in San Diego County. In terms of acreage, more agricultural land in San Diego County is in avocados than any other crop, and there is a high percentage of land in ranches that do not have high-quality croplands (County of San Diego DAWM, 2014). San Diego has very little flat land for agricultural, and avocados are able to grow on relatively steep slopes. According to NRCS definitions, this kind of land would not be considered “prime,” even if it is more than adequate for growing avocados. Thus, farmers in San Diego are much more likely to want to protect “non-prime” land than
their counterparts who farm on the flats of the San Joaquin Valley, or the non-prime land is in ranches that are already far removed from urban encroachment.

Another difference between San Diego and the rest of California is that San Diego County is a very urban county, even among the other counties classified as “urban.” Agriculture only comprises a very small part of the county’s economy, which creates more pressure for urban land conversion. When land values rise rapidly, prime agricultural land (which is likely some of the flattest land remaining in the county that has not already undergone conversion) is under much greater pressure than in other counties. The fate of San Diego County’s farmland seems to be less dependent on land conservation efforts at the state level, and more on the urban land market at the county level.

In short, the geography of San Diego County, as well as the nature of the agriculture in the county, creates an environment that the CLCA is simply not designed for. If farmland preservation in the region remains an important concern for San Diego County and the state of California, alternative farmland protection measures to the CLCA should be considered.

**Water**

**Drought and Availability**

Unlike many other parts of the country, winter is a verdant season in southern California. Winter is when most of the rain tends to fall in the region, and cooler temperatures (averaging around 65°F) facilitate growth of all kinds of life in the region. For this reason, winter weather is critical for agriculture in the region, in a way that is similar to the importance of spring weather patterns for farmers in the Midwest.
Even without sufficient winter rains in San Diego County proper, farmers can manage to keep their crops alive using irrigation. Importantly, the viability of these irrigation sources is often disconnected to local rain patterns, since irrigation sources tend to draw from distant watersheds. This is where a “problemshed” perspective is necessary in order to understand the true magnitude of the issues facing San Diego farmers.

As was noted in chapter 3, rainfall in San Diego County may provide only a small percentage of the total water needed for an orchard (in the example above, 17%), meaning the large majority of the water needed for an average orchard may need to be provided by irrigation. Since there are few large freshwater sources in San Diego County, much of that must be imported.

The SDCWA estimates that about 84% of water that was used in San Diego County in 2011-2015 was imported, largely from two sources: the California State Project and the Colorado River Aqueduct (SDCWA, 2015). The California State Project carries water from the San Francisco Bay-Delta more than 600 miles to deliver water to the MWD and eventually to the SDCWA (“California State Water Project Overview”). The Colorado River Aqueduct carries water from the Colorado River across the entire width of California also to the MWD. The MWD then sells this water to the SDCWA, which in turns sells the water to its member agencies.

The watershed of these two river systems is immense. The Colorado River basin drains an estimated area of 246,000 square miles, an area roughly the size of France (Bruce, 2012). The San Francisco Bay-Delta watershed (from which the State Water Project flows) drains an estimated area of 75,000 square miles in California (EPA, 2015). The two major sources for these watersheds are the two great mountain ranges of North America: the Sierra
Nevadas (two hundred fifty miles north of San Diego County) and the Rocky Mountains (seven hundred miles northeast). Thus, growers in San Diego tend to worry as much about levels of snowpack at the source of their irrigation network as what is happening in San Diego itself, a practical outworking of the problemshed approach introduced in chapter 1.

In recent years, the Sierra Nevada (the “snowy range”) has reached only a fraction of its average snowpack over the winter (Lloyd, 2014). The snow in the Sierra Nevadas is what becomes the runoff water that eventually runs into the San Francisco Bay-Delta, much of which is eventually shuttled down to the MWD in southern California (“California State Water Project Overview”). This lack of snow is alarming in itself, but it is made all the more so because it is a pattern for the past several water years in California.

The water year in California begins on October 1—when precipitation is expected to begin—and ends on September 30 of the following year. Water Year 2015 (October 1, 2014 - September 30, 2015) was the fourth consecutive year that the snowpack levels in the Sierra Nevadas were below average. Since 2000, the Colorado River Basin has also been experiencing a historic, extended drought that has impacted regional water supply and other resources (“Drought in the Colorado River Basin,” 2015).

This is perhaps no better illustrated than by water levels in Lake Mead. Lake Mead serves as a checkpoint for water in the Colorado River. As mentioned in chapter 2, water in the Colorado River is managed according to the “Law of the River,” including the CRC and

---

30 In water year 2014, for example, the Sierra Nevada only reached about 18% of its average snowpack. (Lloyd, 2014).
the complex of cases, treaties, contracts and other agreements surrounding it. The two major governance units of the CRC are the Upper Colorado River Basin and the Lower Colorado River Basin. Water apportionment between these basins is managed by two dams: the Glen Canyon dam (which creates Lake Powell), and the Hoover Dam (which creates Lake Mead).

Water shortages are often managed by measuring the water levels of the lakes in feet above sea level. In 2007, the Secretary of the Interior adopted “interim operational guidelines that can be used to address the operations of Lake Powell and Lake Mead during drought and low reservoir conditions” (“Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead,” 2015). These interim guidelines stipulate that when the water falls below predetermined thresholds, certain junior water rights holders lose the ability to access the water to “Senior” rights holders, and all water rights holders will have to restrict their usage. In the case of the Lower Colorado Basin, the MWD is the senior rights holder, relative to Arizona water management organizations. The threshold is a lake level of 1,075 ft above sea level, called “Drought Threshold I” (McCann & Cullom, 2014).

For this first time since the lake was filled, Lake Mead fell below 1,075 ft above sea level in May 2016. The lake’s level is currently at a 1073.80 ft at the time of writing—the lowest it has been since April of 1937, when it was first being filled. (US Bureau of Reclamation, 2016). If the water levels do not rise above 1,075 ft by the end of the year, mandatory water restrictions will be put in place on the three states in the Lower Colorado Basin (Johnson, 2007).
In addition to these larger basins being in drought the past decade or so, the NOAA has maintained drought records for the South Coast California Climate Division since 1895. There are many ways to define and measure drought, some measuring short term wetness, some measuring long term wetness, and some that measure both the wetness (long-term and/or short-term) and the cumulative effects of the dearth or surfeit of water, such as low groundwater levels, reservoir levels, etc. The Palmer Hydrologic Index (PHI) is of this last type, and was developed to quantify these hydrological effects of drought. Because of the long-term nature of these effects, the PHI is usually slower to respond to wet or dry conditions than other measures (Timilsena, Piechota, Hidalgo, & Tootle, 2007).

According to the PHI, California is currently in the worst drought in recorded history. Using five-year averages calculated from the yearly PHI values, California has been in a
drought this entire century (Figure 4g), and the past two years have been by far the worst in recorded history. What little rainfall that farmers could expect in previous years has generally failed in the past fifteen.

Figure 4g. Palmer Hydrologic Index: South Coast California Climate Division, 1895-2015

Another factor affecting water availability is seasons. The hottest, driest months of the year are often parched in San Diego County. Escondido, a community near much of the agriculture in San Diego County, averages about 13.98 inches per year of precipitation, but averages less than 0.5 inches per month from May to September (Figure 4h).
Figure 4h. Average monthly precipitation near Escondido, CA: water years 1980-2014

Because of the problem-shed-encompassing nature of these droughts, mandatory water restrictions have been put into place by the SDCWA several years, and historic restrictions were made by the state of California in April 2015. Due to the nature of the water contracts many farmers have with the SDCWA, they were the first to lose access to their normal allotment of water (Personal Communication, farm bureau representative). These contracts were introduced in chapter 2, but for the purposes of this chapter, it is important to note the effects this had on water districts. Simply because users are mandated to use less water does not mean the costs to maintain the water distribution system are largely altered. Water districts are still required to keep more or less the same level of service with less income, and in order to combat this and maintain viability, water districts—from the local water district level up to the MWD—are forced to raise their prices (Personal Communication, water district manager).
Affordability

High water costs were identified as the most important topic among survey respondents in nearly every category (Table 4b). In the words of one respondent, “It seems that almost all avocado farmers are giving up due to the high price of water. This out-weighs all other issues/problems by an extremely high level.”

This sentiment is not without reason. Water rates in the county have increased two-fold in the past decade (see Figure 4i). This, coupled with the drought conditions highlighted above, means that farmers need to buy more water to maintain their orchards, but are hampered both by water restrictions and by the fact that the water they buy is more expensive. As another respondent stated, this is “a losing proposition.”

Fallbrook PUD, Valley Center MWD and Yuima MWD are three of the largest providers of agricultural water in San Diego County, and their agricultural water rates are provided below as typical cases for the trend of water prices in recent years. The water rates for agricultural users have doubled since 2005 (adjusting for inflation), and have created an environment in which farmers find it difficult to make a profit (Figure 4i). This is not to say agricultural users have no relief. The SDCWA has a “Special Agricultural Water Rate” (formerly the Interim Agricultural Water Rate) that allows for local water districts to sell water to agricultural operations at a rate below even the Tier 1 Domestic/Municipal water rate (the rate for domestic customers that use the least amount of water). However, few users are so dependent on water costs for their livelihoods as farmers, and small changes in price have larger effects on growers in the region.
Figure 4i. Water Rates in three representative water districts in San Diego County (adjusted for inflation to 2016 dollars)

Table 4f. Water Rates in 2005 and 2016

<table>
<thead>
<tr>
<th>Water District</th>
<th>Water Rate, 2005</th>
<th>Water Rate, 2015</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallbrook PUD</td>
<td>$494.91</td>
<td>$1,038.28</td>
<td>109.8%</td>
</tr>
<tr>
<td>Valley Center MWD</td>
<td>$595.38</td>
<td>$1,315.63</td>
<td>121.0%</td>
</tr>
<tr>
<td>Yuima MWD</td>
<td>$669.81</td>
<td>$1,205.51</td>
<td>80.0%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>$586.70</strong></td>
<td><strong>$1,186.47</strong></td>
<td><strong>102.2%</strong></td>
</tr>
</tbody>
</table>

Sources: Fallbrook Public Utility District; Valley Center Municipal Water District; Yuima Municipal Water District

Note: These rates only represent the usage rates at the Special Agricultural Water Rate and do not include separate fees such as an infrastructure access charge; all values are real 2016 U.S. Dollars
Water Runoff Regulation

In 2007, the San Diego Regional Water Quality Control Board (SDRWQCB), introduced in chapter 2, issued Resolution No. R9-2007-0104. This resolution was “an amendment to the water quality control plan for the San Diego Basin” originally been passed in 1983 and was intended to carry out provisions in the California Water Code, which regulate runoff into “waters of the state,” which include “any surface or groundwater, including saline waters, within the boundaries of the state” (California Regional Water Quality Control Board, 2007). However, both the original and updated resolution allow for waivers for these regulations for specific types of dischargers if several conditions are met:

1. The waiver must be consistent with the Basin Plan and in the public interest;
2. The waiver must be conditional;
3. Waiver conditions include performance of individual, group, or watershed-based monitoring, except for discharges that the State Water Resources Control Board (State Water Board) or a Regional Water Quality Control Board (Regional Water Board) determines not to pose a significant threat to water quality;
4. Discharger must comply with waiver conditions; and
5. A public hearing must be held.

As with previous iterations of this resolution, a waiver (“Waiver 4”) was allowed for discharge from agricultural operations. In previous iterations of the water discharge requirements, agricultural operations had been allowed to forego the watershed-based monitoring mentioned in Condition 3 above; that changed with the 2007 resolution, which required monitoring of agricultural operations. One reason growers in San Diego County might find this change onerous can be found in the text of the resolution itself:

The proposed amendment will not result in any additional economic burden for dischargers, except for dischargers that would like to be eligible for Conditional
Waiver No. 4, which is for discharges from agricultural and nursery operations (California Regional Water Quality Control Board, 2007).

To put it another way, the only group of people to be hurt economically by this resolution in the eyes of its adopters are agricultural operators.

This is not to say that concessions were not made for agricultural operations. The resolution did allow agricultural operators to create “monitoring groups” to monitor their own discharge collectively, and submit one report collectively. One organization that has been at the forefront of organizing these groups is the San Diego County Farm Bureau, which created the Irrigated Lands Group to help farmers in the region monitor their water in a cost-efficient manner (San Diego County Farm Bureau, 2016).

One justification for this change in the resolution is that nurseries (primarily floriculture and decorative plants) are often highly concentrated operations whose discharges may be highly polluted, and nurseries have been growing in number in San Diego County in recent years. The acreage in avocados has been shrinking, presenting less of a threat to water quality than previously, and water conservation efforts have been increasing due to rising water costs. This lumping together of agricultural discharges may be one reason why farmers feel like many regulations imposed on them are, again, “one-size-fits-all,” especially since, as noted in chapter 3, 21% of the acreage in avocados in the county is organic.

Avocado Market

Overview of General Market Trends

Avocado sales have greatly increased in recent years. As was demonstrated in chapter 2, this increase in the volume of avocados sold in the United States was at least partially
enabled by legislation at the federal level allowing avocados originating from Mexican and other countries to be imported for sale in the United States. However, there have been other factors shaping the increase in sales in avocados in the past decade, encompassing social and economic realities.

**Demand**

No doubt sales of avocado have been bolstered by their promotion as a “superfood.” Though the term superfood is little more than an advertising slogan, it is well-documented that avocados are a nutritionally-dense fruit with many health benefits, including decreased risk of coronary heart disease, cataracts, diabetes, benign prostatic hypertrophy, prostate and other cancers, and age-related macular degeneration (Bost, Smith, & Crane, 2012).32

In any case, the avocado has seen a surge in popularity in recent years. The HAB has tracked the sales and imports of Hass avocados since 2004. Avocado sales are seasonal, with fewer avocados being sold in the winter than in the summer months, and have been increasing steadily over time. The summer months in 2004 averaged 13.7 million avocados sold per week (dipping down to 10.7 million in the winter); in 2014, the summer months averaged 33.7 million avocados sold per week (with a winter low of 22 million). Preliminary data from 2016 shows the winter low to be over 30 million avocados sold. This is a nearly 300% increase in sales in just over a decade (HAB, 2016).

---

32 Avocados also have a high protein level for a fleshy fruit (2-4%), the highest levels of potassium among common fruits (greater than that of the banana), high concentrations of antioxidants, and appreciable amounts of several vitamins, including A, E, and B. Some have predicted that edible oil extracted from the pulp of avocado may be an important part of the future avocado market (Bost, Smith, & Crane, 2012).
The increase in demand is likely due to a provision of the trade agreements and laws introduced in chapter 2, which requires countries importing avocados into the United States to dedicate a percentage of their funds to marketing in the United States. This created a larger demand throughout the country, and, as one informant put it, “the tide has continued to rise” for all producers seeking markets in the United States, leading to an “unprecedented” level of consumption (Personal Communication, industry marketing representative).

**Figure 4j.** Hass avocado sales in the United States, 2004-2014

![Graph showing avocado sales in the United States from 2004 to 2016.](source)

**Supply**

The supply of avocados has been keeping pace with the increasing demand in the United States; however, the source of avocados is changing rapidly. Foreign importers are taking a larger share of the market, especially Mexico, which increased from importing just over 200 million pounds per year in 2005 to over 1.3 billion pounds of avocados per year in
Peru, though relatively small in terms of the total tonnage, has also increased its output to the U.S. exponentially in recent years.

**Figure 4k.** Volume of Hass avocados for U.S. markets (pounds), 2005-2015 (3-year avg.)

The data fits well with what survey respondents reported: that they are facing increased competition from foreign imports, and at least one stakeholder noted that for San Diego County agriculture in the past few decades “the biggest change occurred when Mexico was granted access to the U.S. in terms of imports” (Personal communication, industry marketing representative). Other key stakeholders were quick to note that the increase of foreign avocados has kept markets stable during down months, and even increased opportunities for many farmers (Personal Communication, industry representative). This assertion may be
supported by the market data, which seems to show a general decrease in the volatility of the avocado market in the past three to four years (Figure 4l).

**Figure 4l.** Average price per avocado in the United States ($), 2004-2014

![Average price per avocado in the United States (2004-2014)](image_url)

Source: The HAB; *Note: 2015 data unavailable

**Figure 4m.** Volume of Hass avocados produced (pounds) in California and San Diego County, 2005-2014

![Volume of Hass avocados produced (pounds) in California and San Diego County (2005-2014)](image_url)

Source: The HAB; San Diego County Dept. of Agriculture Weights and Measure
In that same time period, San Diego County also continued to produce slightly fewer tons of avocados (though on much fewer acres). It did not contribute significantly to the fulfilling the increased supply needed by an increase in avocado demand.

In fact, the production of avocados in San Diego County has remained more or less consistent for the past twenty years, following a spike in the 1980s as “investment orchards”—orchards planted primarily for tax savings—came to maturity. Although production has remained consistent since the 1990s, the amount of land on which this production has taken place has decreased immensely. In 1990, San Diego County had about 33,000 acres of avocado orchards, and was producing about 84,000 tons of avocados. Two and a half decades later, in 2014, avocado orchards now occupy just over 18,000 acres in San Diego County, but farmers still produce about 83,000 tons of avocados (County of San Diego DAWM Weights and Measures, 2014). Thus, the efficiency of avocado output in San Diego County has been greatly increasing in the past several decades, even if that efficiency is not reflected in gross production numbers (Figures 4m and 4n).
To summarize the points made in this section, the United States has matched supply with the increasing avocado demand by increasing avocado imports in the past decade. This seems to have created a relatively stable market, and does not seem to have crowded many U.S. growers out of the market.

Policy and Economic

One of the most significant policies at the county level with respect to agriculture in recent years has been the passage of the boutique (or tiered) winery ordinance. The boutique winery ordinance was first passed in August 2010 with the primary component of creating a Boutique Winery tier in the zoning ordinance, which allowed for tasting rooms in conjunction with ongoing agricultural vineyard operations (Boutique Winery Ordinance, ...
2010). This was likely responsible for much of the 68% increase in vineyard acreage between 2010 and 2012.

Additionally, the specific language of the county-level policy enabling “agricultural preserves” in San Diego County is important, in that “the establishment of the agricultural preserve and consequent reduction in assessed value of land, if any, shall not place an unreasonable burden on other property owners” (Agricultural Preserves, 1968). This is important, since it requires a much greater input in San Diego County to preserve even a small amount of land using a preferential tax framework than other parts of the state. This means that as land prices increase, the county is going to be less able to afford to maintain lands in the CLCA, particularly prime lands. Whereas non-prime lands are likely to be difficult and costly to develop because of steep slopes, prime lands are likely to be relatively easy to develop. A farmer with non-prime farmland is not likely to gain much from converting it to urban land uses in comparison to a farmer with prime lands, since the same factors that make his or her land “prime” in the agricultural sense make the land “prime” in the development sense.

Conclusion

A survey of San Diego County farmers suggests that some of the most important factors facing the agricultural industry are water, policy and regulations, land values, and market forces. This chapter outlined out key data points with respect to those themes, and confirms much of what survey respondents and key informants indicate.
The next chapter situates this quantitative and qualitative data within the frameworks introduced in chapter 1, and explores the implications this has for San Diego County and other counties with agricultural communities experiencing threats from multiple sources.
Chapter 5
Review and Synthesis

“We are in the midst of a transition to new crops. Avocado & cut flower acreage is declining and in some instances moving into novel smaller crops which include boutique wineries and other agrotourism opportunities.”

-Avocado Grower in San Diego County

Overview

The agricultural industry in San Diego County has been threatened in recent years by a number of factors, each of which on its own would be difficult to overcome. In light of the multiple factors, disciplines, and sectors that are involved in the faltering of agriculture in the region, an approach is needed that considers the many interrelated parts of the whole. This study has taken a transdisciplinary systems approach, as it “integrates the natural, social and health sciences in a humanities context” in order to synthesize knowledge from several traditional disciplines, enabling a multi-sector, multi-level perspective (Choi & Pak, 2006).

The systems approach and framework was introduced in chapter 1, along with the concepts of resilience and problemshed. A concise description of a resilient system not introduced previously comes from the American Planning Association and several other organizations, and it speaks to many of the issues at play in San Diego County:

[A resilient system] thrives in the face of challenges, such as unpredictable climate, increased pest resistance, and declining, increasingly expensive water and energy supplies (Principles of a Healthy, Sustainable Food System, 2012)

Approaching the issues raised thus far from a systems perspective enables integrative analysis appropriate to the complexities inherent in farming in the foothills of San Diego.
County and on the urban fringe in general. This chapter, then, applies social-ecological systems (SES) theory to the data and analyses carried out in chapters 2-4, specifically looking at the resilience of the agricultural production system with the larger food system.

**Systems Thinking and Resilience**

Many indicators of resilience in SES have been developed over the past few decades. One framework that has been applied specifically to agroecosystems is a behavior-based model that compiles 13 behavior-based indicators to determine the resilience of a given SES (Cabell & Oelofse, 2012). Table 5a defines these elements and provides a few examples as to how the trends and topics covered in chapters 2-4 may be understood in the context of this study and the San Diego County agricultural production system in general. These themes are compiled from several different publications; not all of these elements must be present for a system to be considered resilient, and a system may exhibit resilience in one aspect of a SES, and not in another. The examples described in this paper are then compiled in Table 5b by sub-system within the larger agricultural production SES in San Diego County, which is used to organize the remainder of this chapter.
### Table 5a. Behavior-based indicators of resilience for agroecosystems

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
<th>Example from San Diego County</th>
</tr>
</thead>
</table>
| Socially Self-organized                        | Degree to which farmers, consumers, and other stakeholders can organize themselves | • Cluster of Agricultural Institutions  
• San Diego County Home Rule  
• SDCWA                                                                                     |
| Ecologically Self-regulated                    | Maintenance of a system within a certain range of variability or within a certain domain of attraction as an output of regulating ecosystem services | • Permanently good weather (Hardiness zone 10/11)  
• Lack of diversity in avocado varieties grown  
• Lack of adequate local water sources  
• Marginal lands  
• Pest introduction                                                                                     |
| Appropriately connected                        | Dynamic relationships between elements within a system and between systems across spatial and temporal scales. | • Access to urban and international markets, and labor  
• Cluster of agricultural institutions  
• Free trade and foreign imports  
• Imported water dependence  
• Educational resources stretched                                                                 |
| High degree of functional and response diversity | Functional diversity is the variety of elements and ecosystem services they provide within the SES; Response diversity is diversity of responses to change among components contributing to same ecosystem function | • Cluster of agricultural institutions  
• Growing diversity of agronomic techniques  
• Layering of special districts (including water districts)  
• Lack of diversity in avocado varieties grown  
• Lack of adequate local water sources                                                                 |
| Optimally Redundant                            | The presence of superfluous units that have some degree of functional overlap within the system. This overlap serves as a buffer against risk and shocks; redundant systems are more capable of transformation and persistence | • Layering of special districts (including water districts)  
• Free trade and foreign imports  
• Cluster of agricultural institutions  
• Regional Water Quality Control Board  
• Lack of adequate local water sources  
• Lack of educational institutions                                                                 |
| High degree of spatial and temporal heterogeneity | Lack of uniformity across the landscape and through time. A system with heterogeneous patterns of land use and crops varieties over time is more resilient against future changes | • High degree of environmental heterogeneity  
• Adaptive development over time  
• Decreasing land available for agricultural use  
• Climate change effects                                                                                     |
| Carefully exposed to disturbance               | Disturbance releases resources that were sequestered or bound up so other components can take advantage of them while forming new configurations; disturbance loosens rigidity. | • Repeated shocks  
• Growing diversity of agronomic techniques  
• Water supply diversification  
• Large shocks  
• Lack of control over entire problem                                                                 |
| Responsibly coupled with local natural capital | SESs should begin to live within the means of the local resource base; this must be done responsibly, not to the point of causing ecosystem collapse | • Permanently good weather (Hardiness zones 10/11)  
• Avocados adapted for growth on slopes  
• Water supply diversification  
• Lack of adequate local water sources  
• Marginal lands                                                                                     |
| Reflected and shared learning                  | The ability to learn from past experiences and share knowledge allows actors in the system to anticipate the future based on experience rather than simply react to present conditions. | • Cluster of agricultural institutions  
• Access to urban and international markets, and labor  
• Water Supply diversification  
• Educational resources stretched  
• Part-time growers                                                                                     |
| Globally autonomous and locally interdependent | A system has autonomy from exogenous (global) influences and exhibits high level of cooperation among institutions at the more local level | • Relative isolation/“End of pipeline” syndrome  
• Large single units of governance  
• Free trade and foreign imports                                                                                     |
| Honors legacy while investing in the future    | The system’s history largely determines its future; legacy is important for continuity as system goes through changes; can be used to build resilience | • High value and value-added crop (organic)  
• Water supply diversification  
• Urban development patterns  
• Federal investment                                                                                     |
| Builds human capital                           | Human capital is built upon social resources such as knowledge, skills, and experience, mobilized through social relationships and membership networks | • Cluster of agricultural institutions  
• Relative isolation/“End of pipeline” syndrome  
• Educational resources stretched  
• Part-time growers                                                                                     |
| Reasonably profitable                          | Farmers should be able to make a livelihood from their efforts while acting as stewards of the land | • High value and value-added crop (organic)  
• High water costs  
• Proposition 13                                                                                     |


Note: Green indicates components that contribute to indicator; Red indicates those that detract from indicator; Black indicates neutral or both effects.
The most salient factors that have positively or negatively affected resilience in the agroecosystem of San Diego County are highlighted in Table 5a and throughout this work. The remainder of this chapter explains how these factors have affected resilience in the San Diego County agricultural production system (Table 5b).

Subsystems of the Agricultural Production System

Adaptation and transformation are two ways that a system might display resilience, as noted in chapter 1. Adaptability “represents the capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current trajectory,” and transformability “is the capacity to cross thresholds into new development trajectories” (Folke et al., 2010, p. 1). It is likely that different subsystems within the larger San Diego County agricultural production system will adapt or transform to disturbances differently.

Table 5b. Subsystem components in the San Diego County agricultural production system

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Components of Subsystem</th>
</tr>
</thead>
</table>
| Economic      | • Cluster of agricultural institutions  
|               | • Free trade and imports  
|               | • Urban Proximity  
| Agronomic     | • Novel techniques/technologies  
|               | • Marginal land and soil  
|               | • Value-Added and High Value Crops  
|               | • Crop diversity  
|               | • Lack of professionalism  
| Water Resources | • SDCWA  
|               | • Layering of special districts (including water districts)  
|               | • Local water supplies/import dependence  
| Biophysical   | • Temperature and climate  
|               | • Drought  
| Social-Political | • Proposition 13  
|               | • Local autonomy, home rule and “end of pipeline” syndrome.  
|               | • Educational resources  
|               | • Large problemshed  

Agricultural Institutions Cluster

The array of agricultural institutions in and around San Diego County—especially with respect to avocados—was discussed briefly in chapter 2. These may collectively may be referred to as an economic cluster. An economic cluster is defined as “the geographic concentration of firms related by knowledge, skills, inputs, demand, and other linkages” (Delgado, Porter, & Stern, 2015). The presence of related economic activity is important for regional and industry performance, and is a positive contributor to the resilience of San Diego County’s agricultural production system.

One way to measure a cluster is by an industry’s location quotient (LQ). LQ measures an area’s distribution of employment by industry compared to a reference area’s distribution (“BLS - Location Quotient,” 2013). Although anytime the LQ for an industry is greater than 1 the region may have a competitive advantage, the most important industries in a region often have a LQ of 2 or higher (twice the national or state average).

The LQ for “Crop production” in San Diego County is 1.44, making it the 9th most important industry in the county and putting it in the top 10% of industries in the county. The relative strength of the industry, institutions and organizations there are an important aspect of the county’s agricultural production system resilience.

\[ \text{LQ} = \frac{\text{Employment in industry}}{\text{Reference area employment}} \]

\[ \text{LQ} > 1 \text{ indicates a competitive advantage} \]

33 For example, building construction represents 1.17% of all employment in the United States, but 1.29% of employment in San Diego County. Dividing 1.29%/1.17% produces a LQ of 1.10 for building construction in San Diego County.
Free Trade and Imports

Also discussed in chapter 2, the movement towards trade liberalization and regionalism has had delayed, but potent, effects with respect to avocado agriculture in San Diego County, partially because the USDA only gradually allowed Mexican avocado imports, in many ways ensuring that the San Diego growers were carefully exposed to disturbance.34

It is uncertain whether in the long term free trade has increased the resilience of the agricultural production system in the county, but, as noted previously, it has created price stability, greater demand, and more familiarity in the domestic avocado market, all of which contribute to a more resilient system, relating as it does with global autonomy and local interdependence. However, it has also created competition and competitive institutions, and has introduced pests into San Diego County. Though not from Mexico—the largest avocado importer—the polyphagous shot hole borer is one imported pest crippling many orchards in San Diego County (“Polyphagous Shot Hole Borer,” 2013). Pests like these may diminish ecological self-regulation in the short-term, but if growers are able to sufficiently manage pests and innovate to create generalizable solutions, it may contribute to long-term resilience in that indicator as well.

34 This may be a contentious claim, however, as many would rather have not been exposed to what they might see as an unnecessary disturbance
Undoubtedly one of the most significant threats to the production of avocados in San Diego County is high and rising land values, which has led to more land in urban uses. This diminishes the ability of growers to be reasonably profitable and reduces the spatial heterogeneity of the landscape. This is perhaps the largest threat to the resilience of agriculture in San Diego County in the long and medium term. Having said that, the proximity of the avocado orchards to urban areas provides a number benefits in terms of institutions, infrastructure, and access (to labor, capital, markets, etc.).

**Agronomy**

Many growers are undertaking significant changes in their management practice in order to cope with the changes they see around them. As mentioned in chapter 4, updated irrigation systems are the most common management change that farmers undertook (Table 4b). Five of the top seven management changes are agronomic in nature, demonstrating that avocado growers are having to rethink the way they grow avocados.

**Novel Techniques and Technologies**

Updating irrigation systems is the top management change mentioned by growers in the survey. This may mean installing more efficient technology, such as drip irrigation, or it may mean re-calibrating older systems to waste less water or energy in their operation (Personal Communication, extension advisor).

One relatively extreme management practice that has been gaining popularity in recent years, and which may be captured by “Planted/pruned trees differently” above, is a
practice called stumping. Stumping is when all the greenery is cut off of a mature avocado tree to conserve water for that year. Stumping has been recommended for quickly reducing water use since at least 1988 (Bender & Engle, 1988); however, this was primarily recommended for trees that had canopied and were at more or less their full mature height. In recent years, stumping has become a more mainstream practice even before trees have reached their full potential height, and has been accompanied by other pruning methods.

Most notable of these alternative methods is called dense planting, for which the UCCE has been running trials in recent years to test the efficacy (Personal Communication, extension advisor). Dense planting is, as it sounds, allowing avocado trees to mature more densely in an orchard, pruning more aggressively to maintain a tree’s viability and reduce shade-out. While dense planting is not likely to reduce the amount of water used on a given acre, preliminary data from UCCE suggest that water will be used more efficiently to produce more avocados per acre using this system (Personal Communication, extension advisor). More avocados mean more revenue, which it is hoped will cancel out effects of rising water costs. If this technique proves to be effective, it may be a useful tool for increasing the resilience of the San Diego County agricultural system by increasing the profitability and the ecological self-regulation of farms in the region.

Value-Added and High Value Crops (Organic avocados)

Many growers also mentioned switching to organic growing to capture the high prices that organic avocados bring. San Diego is already a leader with respect to organic growing, with about 21% of the total acreage of avocado orchards in San Diego County being certified organic, as shown in chapter 3. The strength of the organic avocado industry in San Diego
County is an asset towards greater resilience in terms of being reasonably profitable and honoring legacy while investing in the future, as it creates a larger profit margin than standard avocados and can use much of the existing infrastructure in the county.

**Marginal Land and Soil**

As was observed in chapters 2 and 3, many avocado groves in San Diego County are located on marginal lands and marginal soils. Though there is little that can be done to change the topography or soils in a given location, these orchard locations have moved to more marginal lands over the years. This may seem like it detracts from the ecological self-regulation and responsibly coupled with local natural capital components of resilience—and in many ways it does. It is important to take a broader view, however, recognizing that while the land is not as suited for agriculture generally speaking, the avocado groves are responsibly coupled with local natural capital by using the land in a unique way unavailable to growers in other regions. It also represents “safer” land in terms of likelihood of being converted into urban use, and contributes to the SES being carefully exposed to disturbance.

**Crop Diversity**

Crop diversity may be one of the most significant ways in which the avocado production system in San Diego County has been decreasing in resilience in the past several decades. As noted in Chapter 3, the diversity of varieties of avocados grown in San Diego County has all but disappeared, with Hass dominating about 94% of the land in avocados. This is especially risky, in part because it decreases ecological self-regulated nature of the orchards (avocados are especially sensitive to diversity in flowering). It also reduces the
optimal redundancy, as avocados tend to alternate years of being productive, a reality which may be mitigated by having a greater diversity of varieties. The reason farmers grow monoculture orchards is to increase profitability, as most other varieties besides Hass have only a very small market, but this may be a short-term gain in resilience at the expense of long-term resilience.

Part-Time Growers

San Diego County and the surrounding region has the interesting characteristic of being simultaneously one of the most important research centers for avocados in the world, and also having a large portion of its primary operators being part time or retirees. Many growers buy homes with orchards on the land, and maintain the orchards as a way to pay property taxes (Personal Communication, industry representative). Creating resilient agroecosystems may not be the primary priority of casual orchardists, which may detract from building human capital at the county level and engaging in reflected and shared learning. On the other hand, it may create a high degree of functional and response diversity, as there are many different kinds of farmers with different motivations who will respond differently to shocks and stressors. Overall, the proportion of part-time growers does not likely create resilience for the agriculture production system as a whole, but may contribute to resilience at certain levels and for certain system components.

Other

There are other agronomic innovations that may contribute to greater resilience for the San Diego County agricultural system. Some of these include better technology for harvesting on steep hillsides (including solutions as diverse as llamas and drones) and
switching to different crops. The latter may be considered transformability rather than adaptability, depending on the scale, and is discussed in more depth below.

**Water Resources: Self-sufficiency and Diversification**

*San Diego County Water Authority*

The SDCWA is the primary institution in San Diego County responsible for the procurement of water for agricultural and domestic uses. It is the largest member institution of the largest public water district in the United States, and serves a great diversity of constituents. Previously, especially before 1990, though it was highly *socially self-organized* and brought together a number of stakeholders in the water resources subsystem, it is not clear whether it has been *ecologically self-regulated*, relying as it has on external agencies for most of its water.

Chapter 2 illustrated how special district financing has grown more difficult in the past few decades. However, the presence of multiple layers of water districts (MWD>SDCWA>local water districts) provides a kind of resilience to the county’s water users. This may best be illustrated as contributing to the *optimal redundancy* of water resources institutions in the county. Though the local water districts, the SDCWA, and the MWD serve similar functions, the fact that they operate at separate scales and encompass slightly different responsibilities allows for local sensitivity and advocacy, an aspect of *functional and response diversity*. This may be illustrated by the recent litigation between SDCWA and the MWD, in which the SDCWA felt its users were charged unjustly high rates. Without institutional diversity, this may not have been addressed. They are *appropriately connected* in that they work together, and even would not exist without each other.
Import Dependence and (Lack of) Local Water Supplies

The SDCWA serves about 95% of the population in San Diego County. Since about 1991—when a severe water shortage in California caused the MWD to impose a 20% water cut on San Diego County’s urban users and a 50% water cut on agricultural users—the SDCWA has sought to diversify its water portfolio (Golakoff, 2013). Indeed 1991 is viewed by many as the pivotal year in which San Diego County began a route towards ecological self-regulation, global autonomy, and more responsible coupling with local natural capital. In all SDCWA annual reports available since the turn of the century, 1991 is the baseline year by which progress is measured in terms of water supply diversification.

Biophysical and Environmental

Temperature and Climate

The climate of San Diego County—in particular the temperature—is perhaps the most important factor contributing to the agricultural production system’s resilience. Being one of the few places in the United States with hardiness zones of 10 and 11, it is responsibly coupled with local natural capital by growing unique, subtropical fruit domestically. Additionally, due to the many microclimates of the county, it is able to support and optimally redundant diversity of agricultural crops, with a high degree of functional and response diversity in the production system as a whole.

Drought

The recent historic drought in California and San Diego County has brought to light the several ways in which San Diego County is and is not resilient. Largely because of the
water supply diversification campaign mentioned above, San Diego County as a region has been able to adapt better than most other regions in California to a lack of water (Cook, 2015). However, the drought has revealed the extent to which agricultural water users in particular do not exist within a system that is ecologically self-regulated. The relative lack of diversified water sources highlights the lack of optimal redundancy in the water supply system, and serves to show that the county’s agricultural production system is not responsibly coupled with local natural capital, relying as it does on imported water sources and sources subject to failure.

Social-Political Systems

Proposition 13

Proposition 13 is something of a double edged sword in terms of resilience; though its effects are strong, they are also diverse. On the one hand, it decreased the amount of taxes farmers and other actors in the agricultural production system would have to pay, contributing to reasonable profitability. On the other hand, it decreased the amount property tax going to fund water districts, which led to an increase in water costs that fell heavily on agricultural users, decreasing profitability. It also diminished the options for water districts to pay for expenses, limiting their functional and response diversity. However, it may also have reduced the pressure on land values by decreasing the cost of housing. Overall, Proposition 13 likely detracted from the resilience of the agricultural systems, but its effects may be too complex to interpret.
Local autonomy and Home Rule

As noted in chapter 2, California and San Diego in particular have a strong tradition of local autonomy and home rule. This, coupled with the “end of the pipeline” syndrome of many of San Diego’s governance institutions and the fact that all of the San Diego MSA is located within a single county, creates an environment in which there is high potential for social self-organization. It also enhances the ability of San Diego County to be globally autonomous and locally interdependent, as has been illustrated by the water supply diversification strategies of SDCWA.

Educational Institutions

A factor limiting the resilience of the agricultural industry in San Diego County is the lack of formal academic resources in San Diego County devoted to agriculture, horticulture, or related sciences. Of the five major four-year universities in San Diego County—San Diego State University, University of San Diego, University of California in San Diego, California State University-San Marcos, and Point Loma Nazarene University—none of these have any kind of agricultural school or degree program. While Mira Costa College in Oceanside and other community colleges offer two year associates degrees in horticulture and related programs, one informant working in agriculture in San Diego County put it this way:

It’s frustrating because...a lot of the students [at local community colleges] are really good horticulture students and they’re going to go on to four-year college.

And there is no four-year college degree in horticulture in San Diego County.

(Personal communication, extension advisor)
University of California-Riverside is in the county bordering San Diego County and does have a horticulture program with a specific focus on avocados, and is considered one of the strongest agricultural universities in the state.

In addition to the lack of institutions of higher learning focusing on avocado agriculture in the county, budgets for UCCE and other more community-based agencies are being cut. Many extension agents and other key stakeholders are being forced to cover multiple counties, which is problematic when San Diego County and its neighboring counties are larger than several U.S. states. As resources are thinning, they are being pulled back to those places where they have institutional support, which in this case, is Riverside County.

The lack of horticulture programs in higher education in San Diego County is detracting from the ability to enhance reflected and shared learning in the agricultural SES there.

Additionally, avocados are a relatively newly-domesticated. Education and research institutions are desperately needed, especially as conditions change for growers in the region. Fortunately, San Diego County has a large cluster of agriculturally-oriented firms, societies, and agencies, and industry-based research in avocados is strong in the county. However, due to the lack of educational institutional resources, San Diego County is less resilient than it perhaps could be in the face of mounting challenges as it seeks to honor legacy while investing in the future.

Large problemshed

The large problemshed inherent to the water resources allotment system and the agricultural production system in San Diego County both contributes and detracts from resilience. Though many aspects of the problemshed have potential to contribute to
resilience, the rivalry between different factions in the problemshed has prohibited many of
the potential gains in resilience from coming to fruition. The (often vitriolic) disagreements
with neighboring states, counties, and water districts has shown that San Diego County is far
from *globally autonomous and locally interdependent* in issues of water resources allotment.

**Resilience Overview**

In summary, there are many factors in the San Diego County agricultural production SES
that both contribute to its resiliency and detract from it. Though the SES has already shown a
considerable measure of resilience in confronting the disturbances of the past few decades,
disturbances will continue to threaten the persistence of the agricultural production SES in
San Diego County.

Though the purpose of this study is less prescriptive than it is descriptive, there are a
few comments that can be made about potential system-strengthening solutions for the
agricultural production system, given the analysis above. These solutions are presented in the
next chapter, along with closing thoughts and conclusions with respect to the San Diego
County agricultural production SES.
Chapter 6
Potential Systems-Strengthening Solutions

“Farming contributes to the food chain, life style, desirability, fire control and security of an area, because it makes the area self-sufficient. San Diego has so ignored its agricultural sector to focus on urbanization that farmers have quit, left or are contemplating leaving. Once it is gone, it will be very difficult to get back.”

-Avocado Grower, San Diego County

Why Protect Agriculture?

The rationality of the protection of agriculture in places like San Diego County is an open question for many people in California and the United States at large. The cutting off of subventions for agricultural preserves in the California state budget in 2009 (discussed in chapter 2) and the county-level ordinance in San Diego restricting preserves that “place an unreasonable burden on other property owners” (discussed in chapter 4) indicate that San Diego County and California may have other priorities more important than preserving agriculture in the region.

However, a large majority of San Diego County residents approves helping agricultural water users with rising water costs, and is in support of agriculture in the region (Probe Research, Inc., 2015). There are many reasons cited by agencies and organizations in southern California and the United States for preserving farmland, including the irreplaceability of farmland, economic losses, ecological services, and aesthetic or cultural amenities (Unger & Thompson, 2013).

In San Diego County, the farmland occupies a unique physical location. The bulk of the farmland—particularly land in avocados—is in the northern part of the county, in the foothills of the Laguna and Cuyamaca Ranges. Incidentally, this is more or less the last strip
of non-urbanized land between the San Diego MSA and the Riverside-San Bernardino MSA, which in turn has already been spilling over into the Los Angeles MSA. As land continues to develop, the benefits of the rural landscape will be lost, including the distinctive character of the San Diego Region in Southern California.

As agricultural communities in other parts of the United States and around the world have addressed similar problems, diverse solutions have been pursued promoting the “multifunctional” nature of agricultural. The Swiss government’s Office of Agricultural, for example, identifies the multifunctional role of agriculture as important to maintaining the beauty and vitality of the people and landscapes of the country (Botsch, 2004). Switzerland is dealing with many similar issues that San Diego County is facing—small farms, diverse microclimates, difficult terrain, harsh climatic trends, and densely-populated urban areas (p. 3). Agricultural policy in Switzerland since the late 1990s has focused on the aesthetic and ecological function of agriculture, but recognizes the many roles that agriculture plays in rural communities, advocating that “the many demands of society today can best be met by a multifunctional agricultural sector” (Botsch, 2004, p. 6).

Despite the many obvious differences with Switzerland, San Diego County similarly will need to emphasize and support the “multifunctional” nature of agriculture in the county if the agricultural production system in the county is to survive. This may take many different forms and approaches. The remainder of this chapter highlights a few solutions for San Diego County that have the potential to increase the resilience of the agricultural production system in the county, and includes socioeconomic solutions, agronomic solutions, and water resource management solutions.
Potential System-Strengthening Solutions

Socioeconomic Solutions

Agritourism and Wineries

As large shocks on the San Diego County agricultural production system are becoming long-term stresses, the ability of this system to adapt and transform will be tested in the coming years, as it has in the past. One way to increase the resilience of the system was mentioned briefly above: economic restructuring and the use of agritourism to increase profits. While this is not to suggest that San Diego County completely abandon its agricultural system, there may be ways to leverage the cultural and social significance of the avocado industry to San Diego County.

This has already been partially captured in Fallbrook, CA—the “avocado capital of the world”—which has hosted an annual Avocado Festival since 1962 (“The Fallbrook Avocado Festival,” 2011). It is a boon for the local economy, and brings to relief the importance of the avocado to the community’s economy. The festival is an example of a non-farm activity that leverages agricultural to create a more resilient, economically sustainable community.

There are other ways to capture agritourism benefits. The number of vineyards in the county is rapidly increasing in recent years, likely due to the lesser water requirement of grapes, policy factors shaping economic opportunities, and systemic disturbances that have pushed farmers away from avocado orchards. The following is taken from the most recent crop report from the San Diego County DAWM:
Farmers are starting to plant drought-tolerant crops like dragon fruit, olives, wine grapes, blueberries, and blackberries to replace more thirsty crops like avocados and citrus. This shift could change our agricultural landscape in the years ahead, boosting the current vineyards and wineries that have become popular destinations to spend the day (County of San Diego DAWM, 2014).

As the number of vineyards in San Diego County has grown, grape growers have organized collectively to create a marketing agency known as the San Diego County Vintner’s Association (SDCVA). The SDCVA connects the tradition of wine growing in San Diego to the 18th century mission vineyards mentioned in chapter 2, framing San Diego as the original “California wine country” (SDCVA, 2015). This is not just true of the mission era, however; as modern agriculture in the region was first burgeoning in the late 19th and early 20th centuries, San Diego County was a center for grape-growing. The 1926 Annual Crop Report for San Diego County, for example, reports 8,056 acres of land in grapes, with 2,396 of those acres in wine grapes. That same year 1,100 acres of avocados were reported, and only 220 of those acres were of bearing age. Before San Diego grew avocados, it grew grapes.

The SDCVA traces the current trend of vineyards to high water costs and natural disasters (SDCVA, 2015), such as the 2003 Cedar Fire, the largest recorded wildfire in California history. It burned over 273,000 acres—more than 6 times the size of the District of Columbia—including thousands of acres of agricultural land that then needed to be replanted (Firetracker, 2016).

For the last ten years that records have been kept, the amount of land in avocados in San Diego County has decreased by nearly a third from more than 26,000 acres in 2004 to
about 18,400 acres in 2014. In that same time, the acreage in vineyards has more than tripled, from 300 acres in 2004 to over 920 acres in 2014. While there is still a significant gap between the acreage in avocados and the acreage in vineyards, the trends for the two crops are clear (Figure 6a).

Figure 6a. Acreage in avocados and vineyards in San Diego County, 2004-2014

![Graph showing acreage in avocados and vineyards in San Diego County, 2004-2014](image)

Source: San Diego County DAWM Annual Crop Reports, 2004-2014
*Note the different axes – avocados still represent over 10x more land in San Diego County than grapes

Depending on the scale of one’s analysis, this may either be considered a transformation or adaptation leading to resilience. For the avocado farmer, it is more likely the former; for the agricultural policy maker, it may be considered the latter. Though the introduction of wine-tasting rooms and wineries in general is one way that growers have been able to cope, adapt, or transform, there may be other opportunities for avocado growers to leverage their proximity to a large urban area and the general support of agriculture in the county. Regardless, even if agritourism is pursued by individual growers or a collective of
Policies must be supported by enabling policies put in place, most likely at the county level.

**Policies, Planning, and Macroeconomics**

Policies—be they tax policies or zoning policies—have historically shaped the San Diego County agriculture system immensely. However, simply creating more policies is not necessarily the solution; policies may either have positive effect on the agricultural system or a negative effect. The strength of San Diego County’s home rule outlined in chapter 2, the example of the boutique winery ordinance briefly discussed in chapters 4 and 6, and the implications of the Tax Reform Act of 1969 also in chapter 2 should indicate that there is much potential at the county level especially—but also at the state and federal level—to intervene and create policies that support a resilient agricultural system in San Diego County. There are many different pathways this could take—this study has highlighted property tax reform, international trade agreements, tax reform, and zoning ordinances, but it has not touched on other important areas, such as more mainstream land use controls, food safety, and food subsidies, which may also be effective. The important consideration here is that the policy environment is incredibly important to the creation and maintenance of agricultural systems in San Diego County and around the world, and there are many avenues through which policy solutions can be addressed (Figure 6b).
**Agronomic solutions**

Addressing the biophysical needs of avocados in a more efficient manner will also be a necessary component of system-strengthening in the future. As was mentioned in chapter 3, the domestication of avocados is still a relatively new science, and there is great potential yet for improvement of yields, the treatment and prevention of pests and disease, the more efficient use of water, and diversification of varieties (Personal communication, extension advisor).

There are currently trials underway in San Diego County with respect to dense planting, an orcharding method designed to increase yield per acre of avocados grown. This
may also be combined with intercropping of A-type and B-type avocado varieties, which has been shown to increase yields (Personal Communication, extension advisor).

Other innovations are needed as well, including the continued development of alternative water sources in the county. Recycled water is beginning to become more popular, especially in the agricultural regions neighboring large municipalities, though it is not without its difficulties. Desalination may be too costly for agricultural users, but may lessen the burden on the entire water distribution system as a whole, and provides a more predictable source of water.

**Water Resources Solutions: Water Supply Diversification**

The efforts the SDCWA has made towards local water supply enhancement have been considerable, and have made the San Diego Region more resilient in the face of decreasing resource availability (Cook, 2015). For that reason, and because water was a common issue on growers’ minds throughout the survey, significant space is spent here on how the SDCWA has been making efforts to increase the county’s control over the water sources available to the county.

Since 1991, the SDCWA has crafted an impressive plan towards water diversification and weaning off reliance from imported water sources in general, and water sources controlled by the MWD specifically, with whom it has had contentious relations in recent years (SDCWA v. MWD, 2016). Besides legal woes with the MWD, there are also biogeophysical reasons for San Diego County to be wary of total reliance on MWD. There are two pipelines that transport water from the MWD to San Diego County, and two pipelines that transport water from the sources to the MWD. If any of these sources were to
be cut off by an earthquake or other natural disaster, the water supply in San Diego County would be in immediate peril (SDCWA, 2016-d). For this reason, along with its water diversification strategy, the SDCWA has also increased storage capacity. A few quick facts serve to illustrate the extent to which the SDCWA is invested in diversification and storage projects in the county:

- As part of the 2003 Colorado River Quantification Settlement Agreement, SDCWA and the Imperial Irrigation District (IID), entered into an agreement in which SDCWA will receive up to 200,000 AF per year for up to 75 years \(^{35}\) (SDCWA, 2016)
- In 2006, SDCWA completed the Coachella Canal Lining project, in which the SDCWA paid for the Coachella Canal to be lined with concrete to conserve water, conserving 26,000 AF of water per year as a result (SDCWA, 2016).
- In 2010, SDCWA completed the All American Canal Lining project, and conserving 67,700 AF of water per year. As a result of this lining project and the Coachella Canal lining project, SDCWA receives an additional 77,000 AF of water per year. (SDCWA, 2016)
- In 2014, the SDCWA raised the San Vicente Dam to store more water. The San Vicente Dam holds much of the water received from MWD, and the dam raise is the largest in the history of the United States (SDCWA, 2015).
- In December 2015, the Claude “Bud” Lewis Carlsbad Desalination Plant began operation, expecting to meet 7-10% of the region’s water demand. At the time of completion, it is the largest desalination plant in the western hemisphere (SDCWA, 2013). Water produced at the desalination plant is energy-intensive and costlier than water transported over 600 miles in the State Water Project, but has the benefit of being locally controlled and drought-resistant (SDCWA, 2016).
- SDCWA has invested heavily in conservation efforts, driving down per capita potable water use in the region by 39% since 1990 (SDCWA, 2015).
- SDCWA has decreased its total potable water use by 21% since 1990, despite adding 800,000 people to its service area (SDCWA, 2015)

\(^{35}\) This agreement led to what is considered by many to be the largest water transfer agreement in the history of the United States.
This trend towards diversification is supported by the general public in San Diego County. A 2015 public opinion poll found that the “water supply/drought” is considered to be the most important issue facing San Diego County today, more than unemployment, immigration, and housing affordability combined (Probe Research Inc., 2015). Supply reliability was the primary water-related concern for San Diego residents, and there was a strong sense of the importance of using water efficiently, with 87% of respondents agreeing that it was a “civic duty.”

From a 1991 baseline of 95% of its water being imported through MWD, SDCWA has reduced its dependence on MWD water to about 57%. It still imports over a large majority of the water it uses, but these imports are now managed by several agreements and several agencies, rather than just the MWD (Figure 6c).

Over the course of this same time period, the proportion of water going to agricultural uses in San Diego County has decreased. This may be due to a number of factors: individual growers using less water, decreased number of acres in agriculture, more efficient irrigation methods, more stringent regulations/restrictions, etc. Regardless, agriculture represents about 9% of the total county usage (down from 16% in 2000), and is currently the smallest of the category of uses in the county (Figure 6d).
Figure 6c. Proportion of SDCWA Water, by source, 1991-2015

Figure 6d. Proportion of water used in SDCWA, by category, 2000-2015

Perhaps for this reason and because of the media attention to the troubles California agriculture is facing, water for agricultural is met with a surprisingly high level of support from all water users in San Diego County. Only 2% of respondents thought providing less water to farms was the most important action to be taken by local water agencies, and 78% agreed that agriculture and local farmers make an important contribution to San Diego County’s economy. Sixty-seven percent of respondents were in favor of maintaining the special agriculture water rates in the SDCWA (Probe Research Inc., 2015).

Closing Remarks

Many factors are driving the current trends in agriculture in San Diego County. Describing all of the drivers and feedback loops that are at play in the agricultural system would take volumes. This analysis has attempted to use a research methodology that enables a holistic understanding of the factors at play in the San Diego County agricultural system from a planning perspective, and to gain a preliminary understanding of the capacity of the agricultural production system in San Diego County to adapt to significant changes in its component processes, institutions, and organizations.

This study has utilized systems theory, drawing on the concept of resilience and utilizing a transdisciplinary, mixed methods approach. It has outlined key contextual factors from historical, geographic, and institutional perspectives. From there, it examined the specific needs of avocado agriculture in San Diego County, highlighting the biogeophysical constraints and opportunities for the industry in the region. It then examined the most salient trends affecting avocado growers in the county, drawing on feedback from key informants and from survey responses from growers in the region as well as secondary quantitative data.
Finally, this study undertook a systems-level synthetic analysis that attempted to draw together the pieces highlighted in previous chapters, outlining key considerations for the creation of a resilient agricultural system in San Diego County in the future.

In conclusion, the agricultural production system in San Diego County has many elements contributing to its resilience and many that are detracting from its ability to adapt or transform to changes. It has already displayed an incredible resilience in the face of overwhelming odds, and ongoing efforts to increase resilience since at least 1990 have already increased the adaptive capacity of the county’s agricultural production system immensely. Given the large scale and diversity of changes to the system, it would be difficult for the agricultural production system to merely adapt to changes and stay within the same “domain of attraction” that has existed since at least the mid-1970s in the region. Though there are many encouraging developments—such as increasing water supply diversification, novel agronomic techniques, and policy enabling a more water-secure agricultural production system—many of the strongest factors leading to systemic change in the county show no signs of slowing.

If farmland protection remains a priority for the county, significant change may be needed in the near future. Otherwise, the system is likely to undergo transformation rather than adaptation, perhaps beyond recognition. More policies (with teeth and funding) are needed to curb conversion of farmland to urban uses, and to strategize efforts to retain prime land in agricultural production; more investment is needed to reduce the costs and increase the reliability of inputs, especially water, for growers in the county; continued research and support for extension education and research in the county is of vital importance as growers
modify their management practices to adapt to changing environments; and continued effort towards creating favorable socio-economic environments in the county is needed.

The story of agriculture in San Diego County is rich and long. Though the agricultural system in the region has proven itself to be quite resilient in the face of considerable shocks, the onus is on farmers, educators, policy makers, and citizens in the region to ensure that their agricultural system remains resilient to the multiple forces that threaten the diversity of economy, environment, and society in San Diego County. With informed innovation and due consideration for the complexity of the system and its drivers, effective action is possible.
References


Avocado Import Grade Regulations, 50 FR § 944.28 (1985).


San Luis Rey de Francia. (2014).


The Constitution of California.


U.S. Constitution, 10 § 1.


http://www.gsa.gov/portal/mediald/167235/fileName/San_Ysidro_Fact_Sheet_-_July_2015.action


Appendices:

Appendix I. Grower Survey

Appendix II. Informant Interview Questions by Module
Appendix I: Grower Survey

Research Participant Information

UNIVERSITY OF WISCONSIN-MADISON
Research Participant Information

Title of the Study:

Agua(cate)

Water, Policy, and Avocado Agriculture in San Diego County, California

You are invited to participate in a research study about how public policy, water rate increases, and other factors have affected the viability of agriculture in San Diego County, with an emphasis on avocado agriculture in the region.

You have been asked to participate because you manage, own, or operate a farm or orchard in San Diego County. Though this research is focusing on avocado agriculture, we are interested in hearing feedback from farmers of all kinds in San Diego County.

Principal Investigator: Ken Genskow (phone: 608-262-8756) (email: kgenskow@wisc.edu);
Student Researcher: Riley Balikian (email: balikian@wisc.edu)

*Agua cate is the Spanish word for avocado, and is derived from the original Aztec word for avocado obscurif.*

*Avocado" is also derived from this word.*
UNIVERSITY OF WISCONSIN-MADISON
Research Participant Information
IRB ID #: 2015-1235

This survey is expected to take 10-15 minutes

*****
This survey is intended only for managers, operators, or owners of agricultural land (commercial or otherwise) in San Diego County, California.

*****

PLEASE READ THE INFORMATION BELOW REGARDING YOUR PARTICIPATION IN THIS RESEARCH STUDY:

WHAT WILL MY PARTICIPATION INVOLVE?
If you agree to participate in this research you will be asked to answer questions relating to your farm management practices and the reasons you make your management decisions. Your participation will consist of one survey session.

ARE THERE ANY RISKS TO ME?
The questions asked in this survey are designed not to obtain sensitive information from you. However, there are small personal and professional risks whenever personal information is shared electronically.

ARE THERE ANY BENEFITS TO ME?
There are no direct benefits expected for you, though results and publications will be made available to local stakeholders to inform better decision-making in the region.

HOW WILL MY CONFIDENTIALITY BE PROTECTED?
The provision of information that could be directly identified with a particular individual is optional throughout the survey. The confidentiality of those who choose to provide their personal information will be protected by disassociating their personal information (including names, current/former roles, and other potential identifiers) from the rest of the data during data analysis. Data will be retained for at least seven years after conclusion of the study for potential future research and for validation of research.

WHOM SHOULD I CONTACT IF I HAVE QUESTIONS?
You may ask any questions about the research at any time. Questions may be directed to the student researcher Riley Balikian at balikian@wisc.edu or the Principal Investigator Ken Genskow at 608-262-8756.

If you are not satisfied with the response of the research team, have more questions, or want to talk with someone about your rights as a research participant, you should contact the Education and Social/Behavioral Science Institutional Research Board Office of the University of Wisconsin at 608-262-2320.

Your participation is completely voluntary. You may withdraw at any time.

*****
This survey is intended only for managers, operators, or owners of agricultural land (commercial or otherwise) in San Diego County, California.

*****
If you wish to participate in this research study, please check the box below indicating that you have read the research participant information, had an opportunity to ask any questions about your participation in this research, and voluntarily consent to participate.

* I have read this research participant information and consent to participate

Farm Questions (1 of 4)

Questions marked with a red asterisk (*) are required.

Farm Questions (Page 1 of 4)
These questions apply to the farm or orchard that you own or manage.

* Approximately how many acres do you currently have in agricultural production at the farm or orchard you manage? (include bearing and non-bearing acres)

Which of the following best describes your role with respect to the farm or orchard you manage?

- The farm/orchard is a commercial operation, and my role there is full-time
- The farm/orchard is a commercial operation, but my role there is part-time
- The farm/orchard is not primarily a commercial enterprise, but I do sell some of the produce
- The farm/orchard is primarily for my leisure
- Other

* Do you currently grow avocados on your farm or orchard?
Have you previously grown avocados on your farm or orchard?

- Yes
- No

Why did you stop growing avocados on your farm?

How many acres of avocado do you currently have planted (bearing and non-bearing)?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing</td>
<td>0</td>
</tr>
<tr>
<td>Non-bearing</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

Have you *significantly* reduced the amount of land dedicated to avocados in the past decade or so?

- Yes
- No

Why did you reduce the acreage of avocados on your farm?
Select which varieties of avocados you currently grow (select all that apply).

- Hass
- Lamb Hass
- Fuerte
- Zutano
- Bacon
- Pinkerton
- Reed
- Gwen
- Other

- We grow more than one variety in close proximity in the same grove for its cross-pollination effects

In addition to avocados, what crops do you grow?

What crops do you grow?

Water Sources (2 of 4)

Water Sources (Page 2 of 4)
The following questions are about the water sources used at your farm or orchard.

- In the past 10 years or so, has your water supply ever been fully or partially reduced by the water authority or water district due to lack of water in the region?

  Yes
No

During which of the following years was it reduced? (select all that you can remember)


Are you currently enrolled in the San Diego County Water Authority’s Transitional Special Agricultural Water Rate (TSAWR) program?

Yes  No  I don’t know

Where does the water for your farm or orchard originate? (answers should total 100%; approximate values are acceptable)

Water system (piped in from water district, utility department, irrigation district, etc.)
Local groundwater source (e.g., a well on your land)
Local surface water source (e.g., river or reservoir on your land)
Rainfall
Other
Total

Do you utilize any data or information from the California Irrigation Management Information System (CIMIS) for managing water use on your land?

Yes  No (If you use another source for climate/weather information, please explain)

Management Questions (3 of 4)
* For each of the following significant management changes, please select those you have made to your farm or orchard in the past decade or so. (select all that apply)

<table>
<thead>
<tr>
<th>Did you change indicated management practice?</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Updated Irrigation System</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Planted trees differently (e.g., changed planting geometry, planted more densely, or grew different varieties together)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Changed crop</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Changed varieties grown (same crop)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pruned trees differently</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Changed land use of part of farm or orchard away from agriculture (or sold land to someone who did)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Obtained a new water source</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Changed marketing strategy</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Hired less labor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Changed pest management strategy</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sold part of the farm or orchard (or leased it for agriculture use)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Bought or leased more land for agricultural use</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Started growing crop organically</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Other 1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Other 2</strong></td>
<td></td>
</tr>
</tbody>
</table>

* For each of the following significant management changes, please select which you have made to your farm or orchard in the past decade or so. (select all that apply)
<table>
<thead>
<tr>
<th>management practice?</th>
<th>Yes</th>
<th>No</th>
<th>No, but would have liked to</th>
<th>Please explain your answer in as much detail as you would like (e.g., why did you not make a change if you would have liked to?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Updated irrigation system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed varieties grown (same crop)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed crop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed land use of part of farm or orchard away from agriculture (or sold land to someone who did)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtained a new water source</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed marketing strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hired less labor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed pest management strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sold part of the farm or orchard (or leased it for agriculture use)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bought or leased more land for agricultural use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Started growing crop organically</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Please drag and drop the five greatest challenges you face in maintaining a viable farm from the list below into the box to the right. 1 = the greatest challenge you face.

**Hint: Drag your top 5 selections to the box first, then put them in the desired order**

<table>
<thead>
<tr>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>High price of water</td>
</tr>
<tr>
<td>Poor quality of water</td>
</tr>
<tr>
<td>Poor soil</td>
</tr>
<tr>
<td>Drought or lack of rainfall</td>
</tr>
<tr>
<td>Frost damage</td>
</tr>
<tr>
<td>Pests</td>
</tr>
<tr>
<td>Diseases</td>
</tr>
<tr>
<td>Labor costs</td>
</tr>
<tr>
<td>Land costs</td>
</tr>
<tr>
<td>Competition from Mexico or other foreign countries</td>
</tr>
<tr>
<td>Competition from other US states</td>
</tr>
<tr>
<td>Low market prices for product</td>
</tr>
<tr>
<td>Policies and/or Regulations</td>
</tr>
</tbody>
</table>

5 Greatest Challenges (1 = the greatest challenge)
Trends and Outlook (4 of 4)

The following questions ask about your perceptions of current trends and the outlook of agriculture in the region.

What trends (if any) have you observed with respect to agriculture in San Diego County in recent years?

These may include new management techniques, market trends, climatic trends, policy trends, or anything else that you think may be relevant.

What is your greatest concern with respect to the profitability/viability of your farm or orchard? (If you are not sure or do not wish to answer, leave the form blank)

In the short term (1-5 years)?

In the medium term (5-10 years)?

In the long term (10+ years)?

What policies, incentives, regulations, or other programs do you think have been most helpful in maintaining a viable farm in San Diego County, especially in the past decade or so?
What policies, regulations, or other programs in place have made it more difficult to maintain a viable farm in San Diego County, especially in the past decade or so?

If you have any other comments or thoughts that you think are relevant, or could provide more context to the questions asked in the survey, please write them below:

Basic Information

Your Information

The questions on this page ask for your information.

Though all of the information on this page may be helpful for the research, you are not required to answer any of these questions, and you may skip to the bottom of this page to end the survey.

We appreciate your time, and hope you will take a minute more to answer these. As stated in the introduction section, all information identifiable with you will be disassociated with your other answers during data analysis to protect your confidentiality.

Thank you for your participation!

Address or location of farm or orchard you manage

Name of Farm or Orchard

Address
Is the farm/orchard you manage located at your primary place of residence?

- Yes
- No

Does any member of your family (including yourself) own the farm/orchard you manage?

- Yes
- No
- We own the farm/orchard, but we do not manage it

Approximately how long have you been working in agriculture? (in years)


Are you a member of any of the following groups, or do you participate in programs run by any of the following groups? (select all that apply, and feel free to comment in the text boxes about the programs)

- San Diego County Farm Bureau
- California Avocado Society
- Mission Resource Conservation District
- An irrigated lands group
- Williamson Act (California Land Conservation Act)
- Other(s)

- None of the above
How is your product distributed? (total should equal 100; approximate percentages are acceptable)

Direct Marketing (farm stand, farmers market, etc.)  0  %
Packing or Processing Company  0  %
Food retailer  0  %
Other:  0  %
Total  0  %

If your farm or orchard currently hires labor during any part of the season, where do most of the laborers live?

1. We do not employ any labor
2. Within 30 miles
3. Within San Diego County but more than 30 miles away
4. Outside of San Diego County but within 30 miles
5. Outside of San Diego County
6. I do not know

Basic Information

Name

Gender

1. Male
2. Female

Age
We appreciate your participation in this research.

If you would like to see the aggregated results of this survey when the survey collection and analysis is completed, please provide your contact information below.

Your contact information will not be used for anything except to communicate research results.

Email
Appendix II: Informant Interview Questions by Module

Stakeholder Interview Questions, by Module:

Personal and professional

- Current/former role in organization/agency/business
- With whom (agencies, organizations, individuals) do you work on a regular basis?
- Is there anything significant about how your organization is structured, or how your partnerships are structured, that helps you do your job more or less effectively?

Water (Farming groups)

- What is the largest concern for farmers with respect to water? (prices, quantity, quality, etc.)
- Increase in water prices
  - Why do you think water prices have gone up so drastically?
  - What has been the effect (on farmers especially, but on other sectors as well)?
- What are the largest breakthroughs in terms of irrigation or water-efficiency in the past several years (e.g. technology, practice, etc.)?
- Are there any other water-related issues besides price and availability that are important for farmers to consider?

Water (Suppliers)

- Describe your relationship with (other) water agencies in southern California:
  - E.g. MWD, SDCWA, Water retailers, State Water board/regional water board, users (from all sectors)
- Increase in water prices
  - Why do you think water prices have gone up so drastically?
  - What has been the effect in San Diego (on farmers especially, but on other sectors as well)?
- How has San Diego fared in the most recent drought compared to other regions?
- What efforts have been done to ensure that agriculture remains in San Diego County?

Avocado Agroecology

- What are the most commonly grown avocado cultivars (and some of their characteristics)?
- What are the most significant pests and diseases?
• Has this changed in recent years? Why?
• How would you describe the fittingness of San Diego’s climate to avocado growing?
• What are the major inputs for growing avocados?
  • Major concerns (e.g. water salinity, fertilizer transport)
• What are the primary agroecological concerns for avocado growers in San Diego County?

Farming and Field Management

• Why do so many farmers in San Diego County grow avocados?
• How has avocado growing changed in any way the last few decades? What are these changes, if any?
  • What has been driving these changes?
  • Are any of these directly associated with rising water costs? With lack of rainwater?
    Lack of irrigated water?
• What are the most significant challenges for avocado farmers to make a profit?
• Are there grants, subsidies, or special programs available to help farmers reconfigure any aspect of their growing system? Anything working against it?
  • New crops
  • Updated irrigation systems
  • New growing methods

Labor/Capital

• Who does most of the labor in San Diego farms?
• What percent of the labor is mechanized? Can it be?
  • Any barriers to mechanization (e.g. landscape, technology, cost?)
• Do most farmers have updated irrigation systems?
• Have there been any large issues associated with labor in the past several years?
• What percent of an orchard’s inputs are labor (financially speaking)?

Land

• Who owns most of the farms in San Diego (demographics)?
  • Why do you think that is?
• Have land prices changed dramatically in the past several years?
  • What is (or is not) driving these land changes?
• Do many people take advantage of the agricultural preservation tax credits?
Market and Economy

- Please describe to me what the avocado value chain looks like in San Diego County?
  - Does this differ from other regions?
- Why has there been a recent decrease in employment in the agricultural sector (in terms of location quotient)?
- Do avocados sell for more now than they used to?
  - Is more supply needed?
  - Is the demand steady?
- Are there any problems for farmers in selling their avocados?
- Where are most of the packers located in San Diego County?

Policy structure

- Do you think San Diego County has a friendly policy environment for avocado growing? MWD/SDCWA? California?
  - Compared to (for example) Riverside County? Florida?
- Have you heard of special interest districts?
  - Do you see these contributing to changes in the local avocado production industry?