We analyze the current uses of the California Irrigation Management Information System (CIMIS), assess the economic gains, and suggest potential strategies for future implementation. We estimate that using CIMIS has led to annual economic benefits of at least $700 million, of which a significant portion is attributed to water savings in non-agricultural sectors. CIMIS demonstrates the high value of public information that enhances water conservation and increases water-use efficiency.

CIMIS was established by the UC Cooperative Extension in 1982 and is managed by the California Department of Water Resources. There are 263 active CIMIS stations, most of which are in the Central Valley and Central Coast. CIMIS weather stations report local weather conditions and reference evapotranspiration (ET). Growers can then use crop coefficients, established by agronomists, to assess the water use of their crop and determine optimal watering schedules.

While there are many other sources of weather information in California, CIMIS data are unique. CIMIS is a freely available public good and provides historical background and regional comparisons. Data from CIMIS are available online (www.cimis.water.ca.gov).

Despite the usefulness of CIMIS, few studies have quantified its economic benefit. A 1996 study found that CIMIS led to a 13% reduction in applied water, an 8% increase in yield, and a total annual economic gain of $32.4 million. In this report, we aim to understand the agricultural and non-agricultural uses of CIMIS, identify barriers to increased adoption, and offer potential strategies for future implementation.

CIMIS use has multiple benefits, from water savings in the agricultural and urban sectors to enhanced yield through more precise irrigation and improved pest control. We estimate that CIMIS generates at least $700 million annually in economic value, primarily driven by the availability and pricing of water on the margin. A large share of CIMIS’s economic benefits is in non-agricultural sectors. Therefore, failure to account for spillovers in CIMIS use may result in under provision of this information source. Due to limitations inherent in any large-scale survey, we only quantify CIMIS’s value in some key areas and leave other areas (e.g., research, policy, and commercial uses) to future research.

Methodology

This study uses qualitative interviews and quantitative survey methods to estimate the economic value of CIMIS among the most significant users of the website. Pre-survey interviews with experts were conducted to obtain information to complement the survey findings. A comprehensive online survey was sent to registered CIMIS website users to assess the narratives, benefits, and value of CIMIS across major user groups. Restricting our analysis to the largest CIMIS users is more relevant and less expensive for estimating CIMIS’s economic benefits relative to establishing a census or representative sample.

In total, we conducted 179 interviews and collected 2,358 completed survey responses. About one-quarter of survey respondents listed their primary user type as “agriculture”, followed by “other” (15%), “government” (13%), “research” (12%), and “environmental design/consulting” (10%). Most respondents (80%) reported only one area of activity.
### Table 1. Estimated Water Savings Attributed to CIMIS Data by Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Consulting</td>
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<tr>
<td>Water District</td>
<td>23</td>
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</tbody>
</table>

Source: Based on author calculations using data from the online survey.

### Economic Benefits in Agriculture

#### Water Savings

CIMIS use leads to water savings primarily through enabling the adoption of precision irrigation technologies, such as drip irrigation. Growers and agricultural consultants in our survey report an average water-saving effect from using CIMIS data of 24% and 21.5%, respectively. We take the lower estimate as agriculture’s (conservative) water-saving effect. Using the 2013 USDA Farm and Ranch Irrigation Survey’s estimates of 2.8 million acres of drip irrigated land in California and an average of 2.5 acre-feet (AF) of water per acre, we estimate the total annual water use for drip-irrigated acreage to be 7 million AF. Thus, using the water saving rate of 21.5%, the amount of water saved by growers who use CIMIS is 1.92 million AF per year.

The net economic value of the water saved using CIMIS data is the sum of expenditures that growers would incur if they purchased the water. Assuming a perfectly inelastic demand for water, which is reasonable in the short term, we multiply the amount of water saved by the price of water. However, water prices in California vary over time and space, making it difficult to determine a single benchmark price for this calculation. Following Taylor, Parker, and Zilberman, we use a range of water prices, $80–$220 per AF, to assess the monetary gains from water savings. For the 1.92 million AF of water saved using CIMIS data, the price range implies annual monetary savings of $154–$422 million. Monetary savings could be even higher in drought years when water prices reach $1,100 per AF.

#### Yield Effects

Since CIMIS allows for more precise irrigation, we also expect yield effects as water application is adjusted to crop requirements. We asked growers to rank how CIMIS data contributes to increasing yields,
from 1 (“none”) to 5 (“a lot”). Previous studies and interviews with experts estimate the average yield effects of drip irrigation to be between a 5% and 25% increase in output. For a lower-bound estimate, we assume rankings between 1–3 signify a 0% yield effect, and rankings of 4–5 signify a 5% increase in yield. For a higher-bound estimate, we assume rankings of 1 signify a 0% yield effect, rankings of 2–3 signify a 5% yield effect, and rankings 4–5 signify a 10% yield effect.

Using these assumptions, we estimate that CIMIS increased crop output (supply) between 2% and 5.9%. The higher output tends to reduce prices. We assume an elasticity of demand of -2, suggesting that a 1% increase in output reduces prices by 0.5%. We also use the weighted average crop value per acre in 2016 of $3,757 per acre, which is slightly lowered due to the increased supply. After adjustment, the yield increase leads to an additional annual income of $38–$111 per acre for growers. For the 2.8 million acres with drip irrigation, the annual contribution of CIMIS to quality from a ranking of 4–5 signify a 10% yield effect.

Quality Effects: Weather data can have quality effects on crops. For instance, using ET data and drip irrigation can increase the quality of tomatoes, leading to increases in the price received by growers. To assess this measure, we asked respondents to rank the contribution of CIMIS to quality from a rank of 1 (“none”) to 5 (“a lot”). Based on the experts’ suggestion, we assume that a ranking of 4–5 corresponds to a quality index resulting in a price increase of 5%. Furthermore, based on previous studies, we assume that the average price increase due to a 1% increase in crop quality is $37.70 per acre. Approximately 45% of agricultural respondents report rankings of 4 or 5. Therefore, the average price increase due to quality improvements is 2.2%, or $83 per acre. The 2.8 million acres corresponds to an increased revenue of $231 million. In total, we estimate that the monetary value of CIMIS on water savings, yield, and quality improvements in agriculture is between $492–$964 million.

However, an alternative approach to assess the economic benefits of water savings in agriculture using CIMIS is to estimate the value of the agricultural output that could be produced with the water savings. As mentioned previously, California was able to increase the acreage of water-intensive, high-value crops without using extra water. With 1.92 million AF of annual water saved due to CIMIS and an average use of 2.5 AF of water per acre by growers (assuming the water goes to drip-irrigated crops), the savings from CIMIS are equivalent to adding the production of a hypothetical 768,000 acres in California.

To value the output that can be produced with the water savings, assuming that the “added land” replicates the existing distribution of crops, we multiply the $3,757 per-acre income estimate for growers by 768,000 acres, resulting in $2.89 billion in extra revenue. This estimate needs to be corrected for the reduction in price due to the -2 elasticity of demand for California crops. Thus, the resulting additional revenue for growers is approximately $1.44 billion. This increase in revenue is larger than the increase in net income. While we do not use this figure in our final assessment, this figure provides another indicator of the magnitude of the agricultural value gained from CIMIS.

Economic Benefits in Non-Agriculture

Landscaping and Golf: Respondents in landscaping and golf reported a total annual water savings from using CIMIS of 220,707 AF. Water prices for this user type are much higher relative to agriculture, and thus the incremental gains from CIMIS are higher. We construct bounds for our estimate using various municipal water rates: for the Los Angeles Department of Water and Power (LADWP) non-profit rate, which is as low as $2.10 per 100 cubic feet, the value of water savings amounts to $201.4 million per year. LADWP also charges commercial, industrial, and governmental water users by tiers, with rates of $5.26 and $8.67 per 100 cubic feet for tiers 1 and 2, respectively, as of January 2019. Assuming we are in Los Angeles and

![Figure 1. Summary of Economic Benefits from CIMIS (Lower and Upper Bounds)](image-url)
90% of the water consumption is in tier 1, the total water savings is $539 million.

Figure 1 (on page 7) provides a summary of the quantified economic benefits of CIMIS. We estimate the annual economic gains from using CIMIS to be between $0.7–$1.5 billion. As previously mentioned, quantifying our qualitative survey findings presents many challenges but suggests considerable economic benefits due to CIMIS. Furthermore, the quantified benefits only represent a subset of total benefits. For instance, gains from research, regulation, and other activities are not quantified and are likely sizable in magnitude.

Relative to the 1996 report, we find the economic gains to be considerably greater in value. This difference may be due to several factors. Since 1996, not only have water prices in California increased substantially, but in response to droughts and new technologies, there is also a greater use of CIMIS and smart irrigation planning in agricultural and urban sectors. While our estimated water savings attributed to CIMIS are large in absolute terms, in proportional terms, this amount only represents 8.2% of the total water used for irrigation in California in 2013. Similarly, the agricultural economic gains we attribute to CIMIS account for around 1%–2% of California’s agricultural income.

Discussion

Our findings suggest that CIMIS data generate at least $700 million annually in economic value, of which a significant portion is attributed to water savings in non-agricultural sectors. Though we do not analyze the operating costs of CIMIS, the gains detailed in this report far surpass these operating costs. These findings also reflect the evolution of CIMIS’s importance to a wide variety of users, which may continue to grow over time. Our research shows how valuable publicly available, research-based information can be in allowing the California agribusiness community to maximize their resources.

California agriculture has changed substantially since the establishment of CIMIS, and many of its current uses are evolving. Having started primarily as an irrigation assistance service, CIMIS is now used in pest management, supply chain operations, and even in sectors beyond agriculture. As California faces the ongoing challenge of climate change, information sources such as CIMIS have become more important for increasing water-use efficiency.

However, CIMIS needs to modernize. At present, CIMIS faces two main challenges. The first is the proliferation of private, low-cost weather stations, which may decrease demand for CIMIS. It is unclear, however, how much growers need data from private stations, given the availability of CIMIS data. CIMIS remains the most important provider of ET data, which are valuable to growers. In particular, CIMIS’s Spatial ET service provides more accurate approximations of local climate. Furthermore, CIMIS’s broad coverage and historical information complement other weather networks and provide verification of private weather data. Private stations also do not give the positive social externality of making the information publicly available.

The other main challenge for CIMIS in agriculture is the accessibility of its website. We strongly suggest enhancing the CIMIS web interface to allow integration with other agro-climatic and economic information sources. Further, we recommend that future research also explore the role of CIMIS as part of the weather information ecosystem, with the aim of combining weather and spatial data and agro-economic information to improve decision-making.

Suggested Citation:

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