The California Irrigation Management Information System (CIMIS)

Intended and Unanticipated Impacts of Public Investment

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The public sector has traditionally provided information to agriculture. Concern about government deficits and scarcity of public resources has led to increased scrutiny of government programs and reevaluation of publicly provided information. Here we assess the performance and future of the California Irrigation Management Information System (CIMIS), a publicly funded program to provide weather information. We identify CIMIS users and show that, at least in this case, the benefits of CIMIS far outweigh the costs. The program increases productivity and saves water; encourages adoption of modern technologies, such as drip irrigation; has unexpected spillover benefits, affecting users beyond the range of intended beneficiaries; and has the potential to generate revenue or be privatized. CIMIS demonstrates how provision of information by the public sector improves efficiency and benefits a variety of users. It provides a model for similar programs elsewhere.

What is CIMIS?

California's Department of Water Resources (DWR) and the University of California developed CIMIS in 1982 to provide current and historical weather information for irrigation management. The system collects and stores climatological data from nearly ninety computerized weather stations around the state, updated on a daily basis. Each weather station transmits data over a telephone line connected to the central database (figure 1). The database may be accessed by CIMIS users twenty-four hours a day via telephone or computer. Users pay no fee for service. CIMIS information is also available in various forms from public agencies cooperating with DWR, from newspapers and radio broadcasts, and through a variety of other public and private channels. Since its inception, the number of users accessing the system directly has grown to almost 2,000, with additional thousands of users receiving the data through these other sources. The system provides fourteen weather parameters including evapotranspiration (ET).

Daily ET and other weather data are crucial to efficient irrigation scheduling. With ET data, irrigators are able to accurately "budget" the amount of water in the root zone. Since CIMIS provides daily information on plant water use, an irrigator can subtract daily from the amount applied at the last irrigation to estimate the amount of water remaining in the soil. The weather data, combined with an understanding of soil conditions, provide a fairly accurate estimate of soil moisture. Without CIMIS information, irrigators must rely on experience or various other means of soil moisture and plant health measurement to determine plant water use. These methods, not based on precise weather knowledge, have varying costs and degrees of accuracy that must be compared to the costs of learning any complementary technologies (software, modem) necessary for CIMIS use.

In general, because price, yield, and weather data may benefit many different users, government has traditionally provided such information. CIMIS stations cost approximately $5,000, with additional station and land maintenance costs of hundreds of dollars per year. One public weather station may be used by many surrounding growers, each of whom saves thousands of dollars in fixed costs of purchasing and maintaining individual stations. Thus, there are increasing returns to scale from public provision of information. It was on this principle that California's DWR founded the CIMIS program. Through the cooperation of water management districts, county cooperative extension offices, and other government entities, CIMIS has grown considerably. The state provides software and professional support for CIMIS, but local agencies and even individual farmers have provided the land and some of the equipment for new CIMIS stations.

CIMIS use has tripled since the late 1980s as a result of the efforts of these public agencies and the recent seven-year California drought. Higher water costs, increased public awareness, and new conservation legislation have all increased the value and importance of efficient water use.

CIMIS shows sizable net benefits

In 1995, Parker et al. conducted a study to determine the costs and benefits of providing CIMIS to California. The results show that the program is a success. CIMIS promotes increased productivity and lower input use. It helps produce an estimated $64.7 million in benefits to California, far exceeding its annual costs of $850,000. Interestingly, CIMIS uses and benefits have expanded beyond the scope of activities for which it was originally intended. These spillover benefits accrue to other agricultural and many nonagricultural activities.

Who uses CIMIS?

The CIMIS system was initially intended as an irrigation management aid, and the study of the system's benefits focused primarily on the benefits to irrigators. In particular, the study concentrated on the distribution of users to whom the data is valuable. The benefits of CIMIS vary by farm and market characteristics: soil and weather conditions, crops grown, variable output and input prices, and technologies used. From the standpoint of either a government agency or a private provider of weather services, identifying the features of the individuals who benefit most from CIMIS and thus are its main users is an important concern. Some of the characteristics of these users include the following:

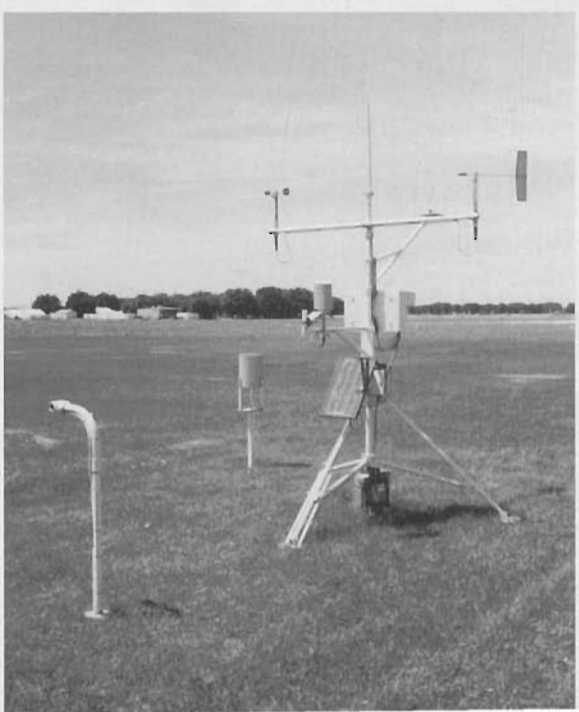
- *Producers of irrigated high-value crops.* Fruits and nuts make up nearly 46 percent of the estimated agricultural acreage under CIMIS, but those crops comprise only 15 percent of the total agricultural acreage in California. Conversely, field crops are grown on only 40 percent of acres under CIMIS, but these crops account for 69 percent of cultivated land in the state.
- *Water users with high water costs.* Average water prices for agricultural and urban users of CIMIS are $90 and $406 per acre foot, respectively. For agriculture, this is significantly above the average statewide price. Urban water prices vary greatly, but it is clear they are high enough to make water cost an incentive to adopt CIMIS.
- *Users of advanced irrigation systems.* Irrigation technology adoption is closely related to both water price and access to knowledge needed to carry out sophisticated irrigation scheduling. A decision aid that can provide information to adapt more quickly to weather changes will be most beneficial to those who irrigate with easily adjustable systems. Approximately 39 percent of CIMIS adopters use drip irrigation or micro-sprinklers, and 36 percent more use other pressurized systems such as sprinklers.
- *Clients of private consultants.* Consultants have profited by using CIMIS for irrigation scheduling, water audits, pest control, and other services. One-fifth to one-quarter of CIMIS users are irrigation consultants for urban or agricultural areas or are pest control advisors (PCAs).

Benefits from CIMIS

CIMIS was created to improve irrigation efficiency. The 1995 study revealed that significant benefits accrued directly to growers as well as to the consultants serving them. To justify continued investment in CIMIS and determine the feasibility of privatization or fees, understanding the magnitude of these benefits is crucial.

- *Survey results showed CIMIS helped reduce agricultural water consumption by 13 percent and increase crop yield by 8 percent.* This translates into an average annual water savings of 42,000 acre feet on the nearly 125,000 acres in the survey. The total value of water use and yield changes to those irrigators is an estimated $14.7 million.
- *Projecting from the survey sample, the aggregate benefits from CIMIS are estimated to be $64.7 million annually.* As table 1 shows, water savings and/or yield increases accrue to high value crops (avocados, lettuce, pistachios, almonds). These benefits are concentrated (figure 2) in the most intensely agricultural counties (Kern, Fresno) in the heart of the Central Valley.
- *Urban parks, cemeteries, and golf courses showed some of the highest water use reductions.* Urban areas in California have among the highest water costs and land values in the country. The CIMIS survey found 8,778 acres of urban parks, landscaping projects, and golf courses using CIMIS information. Their combined water savings were nearly 5,800 acre feet per year. Because these areas pay an average of $406 per acre foot for wa-

Figure 1. A typical CIMIS station in California's Central Valley



ter, their estimated annual savings are approximately $2.26 million.

- *CIMIS helped irrigation consultants save their clients between 11 and 40 percent in annual water consumption.* Consultants may charge from $7 to $20 per acre for their irrigation scheduling services. Some also sell their water auditing services to water districts or produce irrigation scheduling and telecommunications software for use with CIMIS.
- *CIMIS data allowed more efficient use of advanced irrigation systems and computers.* Many irrigators of parks and golf courses have installed centrally controlled, computerized irrigation systems to more easily adjust their water application at various sites. Prior to the adoption of CIMIS, some claimed that the lack of ET data constrained those systems to 60 or 70 percent of their potential water application efficiency.

CIMIS generates substantial spillover benefits

Benefits of public goods and services often reach further than the intended recipients. To date, studies of CIMIS have not been able to fully estimate the spillover effects, but such effects have been identified. Initially intended as an irrigation management tool for growers, CIMIS appears to be as beneficial in pest control as in irrigation, and as advantageous to urban irrigation as it is to agricultural irrigation. The spread of CIMIS data through consulting and media sources, combined with the efforts of cooperating public agencies, has greatly accelerated the spillover process.

- *Pest control benefits.* As many as 80 percent of the PCAs in some California counties use information originating from CIMIS in their pest management activities. Two PCAs claimed pesticide savings of 20 and 40 percent, respectively, from CIMIS use. One organic farmer uses CIMIS daily temperature data with phenology models—tools for calculating an organism's development based on experimentally determined "degree days"—to determine when to release pheromones used to confuse apple-eating moths.

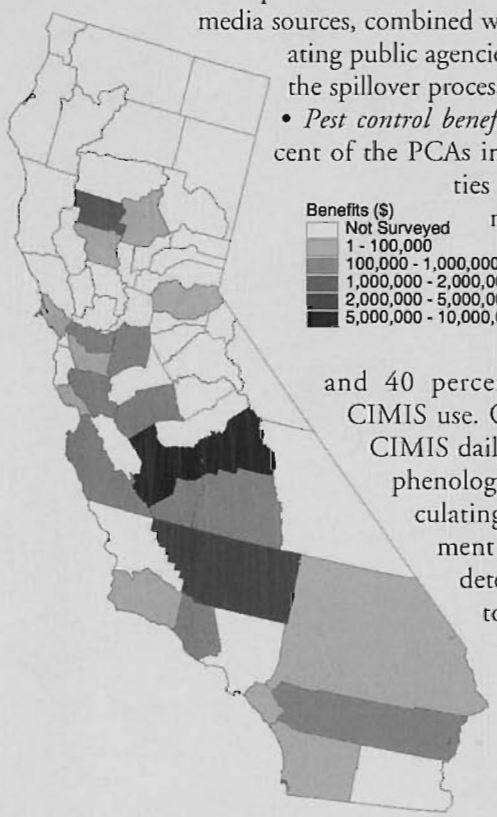


Figure 2. Total benefits (water savings plus yield increases) of CIMIS in California counties surveyed

- *Municipal water districts.* Three Northern California water districts claim annual savings of 10, 16, and 20 percent since initiating irrigation management education programs, including irrigation hotlines that give CIMIS data over the phone. Each of these districts uses tens of thousands of acre feet per year and charges hundreds of dollars per acre foot. Irvine Ranch Water District in Southern California claims to have saved about 1,500 acre feet per year with a block pricing scheme for water. This pricing structure calculates base allocations for households and businesses from ET data provided by CIMIS.
- *Groundwater management.* Some Southern and Central California agencies set allocations and monitor customers' water needs much as described above for urban water districts. For example, the Coachella Valley Water District (CVWD), where Palm Springs sits, is awash with golf courses pumping from aquifers to keep their fairways green. CVWD has marketed CIMIS in conjunction with advanced irrigation technologies as part of a program that has significantly improved the management of the region's scarce groundwater supplies.
- *Legal, public health, and academic research.* A variety of additional benefits are largely underexplored. One private investigator accesses CIMIS's historical data files to estimate past road conditions in auto insurance legal cases. The system's historical data on wind and other conditions have been used in litigation by organic farmers and others claiming damage from pesticide drift. CIMIS is used to monitor air quality in Southern California, where the information is a management tool for regulators trying to prevent health hazards. Its temperature and precipitation data are used by a vector control district to monitor mosquito populations. At the time of the study, the Directorate of Public Works at Fort Irwin in Barstow, California, was exploring the use of CIMIS solar radiation data in a project to monitor and protect the endangered Trenton desert tortoise. At least one-third of the direct users of CIMIS and of the University of California Integrated Pest Management program's IMPACT system, which supplies CIMIS data, are university and cooperative extension researchers whose activities contribute to policy making and productivity in California. Though the impacts of these uses are largely unmeasurable, they are seemingly quite substantial.

The future of CIMIS

CIMIS is a textbook example of a successful public sector activity. The public sector provided the spark for a new institutional innovation that has had both public and private benefits. It is clear that the direct

Table 1. Benefits of using CIMIS on top ten crops

Crop	Acres	Water Savings ($)	Yield Increase ($)	Total Benefits ($)	Benefits/acre ($)
Alfalfa	9,310	95,580	651,400	747,000	80
Almonds	16,190	492,000	4,853,000	5,345,000	330
Artichokes	5,000	5,000	652,400	657,400	132
Avocados	1,940	–282,700	1,476,000	1,193,000	615
Citrus	3,768	–136,200	1,385,000	1,248,000	331
Cotton	25,120	690,600	1,621,000	2,312,000	92
Grapes	8,075	201,700	2,673,000	2,874,000	356
Lettuce	3,700	52,000	2,722,000	2,774,000	750
Pistachios	27,960	740,300	13,510,000	14,250,000	510
Tomatoes, processing	7,280	68,100	360,000	428,100	59

Note: Shown are 10 top crops in dollar yield and water benefits claimed by California growers as a result of improved irrigation management using CIMIS data. Citrus and avocados have negative water benefits because CIMIS revealed to those growers that they were not applying enough water.

benefits from CIMIS are significant. Each dollar of the public investment required to initiate and maintain the system has returned nearly seventy dollars to California farmers and other businesses (Parker et al.) Though difficult to estimate, the indirect benefits of the many CIMIS-based research activities—and of the more efficient water and chemical use CIMIS promotes—could be considerable as well. Its growing uses and benefits show the role the public sector may play by promoting efficiency and conservation through public information.

The remaining question is whether the innovation has matured to the point where it should be self-supporting. CIMIS has facilitated expansion of private weather services and adoption of centrally controlled irrigation systems. A number of growers and urban irrigators have purchased their own weather stations, finding that the initial investment and maintenance costs are worth the added information accuracy. Though public support can help California's DWR continue to expand the use of CIMIS, the funds needed to support the system may, alternatively, be raised directly from users. This might be done either through the imposition of user fees or through privatization.

Privatization is problematic. A private company may be able to provide a superior service tailored toward more-intensive users; however, it may be unable to provide information and data storage for researchers and less-intensive users. At this stage, when the maximum potential to tap CIMIS information is far from being realized, raising the price of information through privatization may slow growth in use of the system. The lost benefits from privatization suggest that the system should remain public, at least for now.

In this case, fees could be levied to help pay for the continuation and improvement of the system, but such fees also pose a challenge. Due to the nature of information, imposing high user fees may cause some users to avoid paying through free riding. The problem is similar to that faced by computer software manufacturers. Just as it is difficult to prevent software sharing, it is hard to limit a purchaser from passing CIMIS information along to many others. Others may refrain from using the system altogether. Alternatively, a low fee would retain more users but might not allow CIMIS to be self-supporting. The current challenge is to design a low-fee system that will both retain the social benefits and reduce the public support of CIMIS. ◙

■ For more information

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