RESPONSES TO MUNICIPAL WATER SUPPLY CUTBACKS IN SAN DIEGO COUNTY, CALIFORNIA, SPRING 1991: FIELD OBSERVATIONS

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TABLE OF CONTENTS

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INTRODUCTION

This report summarizes the results of a Quick Response project funded by the Natural Hazards Research and Applications Information Center to study the impact of the news media and public information on water conservation during a drought emergency. The discussion is drawn from field observations made during the spring of 1991 in San Diego County, California, following a series of cutbacks of water to municipal customers. Additional observations are drawn from the results of a concurrent project focusing on the impacts of water use restrictions in different regions of the United States, including southern California. The latter project was funded by the Illinois Water Resources Center and the University of Illinois Research Board.

Three trips were made to the San Diego area. The initial trip, March 6-11, was made after water deliveries to San Diego County were reduced by 31%, and the second trip, April 4-8, was timed to correspond with the implementation of county-wide mandatory water use restrictions. The third trip, funded by the Water Resources Center, was made on June 1-7 to obtain additional water use data and media information to augment that collected during the previous trips.

The objective of the Quick Response project was to assess the effects of the timing, frequency, and quality of news reports and public information on water use. It was hypothesized that these factors significantly modify individual water use, and consequently can have a profound influence on the effectiveness of conservation programs. However, the observed relationships between water use, water conservation, and the media were much more varied and complex than we had anticipated. Conservation in San Diego County was not simply a news story, it was a media and political spectacle that included scores of news stories, open hostilities between leaders of different cities, scandal, mysterious predictions, and visible public resentment. The media appeared to both influence and be influenced by public attitudes toward these events. Further, the beginning of mandatory conservation coincided with the beginning of an unprecedented spell of wet weather, an extremely significant event which influenced public attitudes, the tone of media reports, and,

ultimately, the conservation programs themselves. Such conditions were hardly suitable for a controlled, scientific study of media impacts.

Nevertheless, substantial field work and data collection activities were completed and a number of general observations were made. Field work consisted of: (1) monitoring newspaper and television news concerning the drought and water conservation, (2) extensive interviews with local water agency personnel, (3) collection of water use data from selected water agencies, and (4) telephone surveys of residential water customers to assess attitudes and responses to water use restrictions. Details of the field work are given in brief reports submitted to the Natural Hazards Center following each trip (Shaw, 1991a,b). Subsequent investigation included follow-up interviews, compilation of survey results, and a time series analysis of daily and weekly water use during the drought emergency.

BACKGROUND

Study Location. Field observations and analysis focused on San Diego County and adjacent areas of urban (coastal) southern California. The current population of San Diego County is about 2.3 million persons, while the population of the larger area served by the Metropolitan Water District of Southern California (MWD) is estimated to be about 15 million persons (San Diego County Water Authority, 1991a). The MWD delivers about 600,000 acre-feet of water annually to San Diego County, comprising approximately 94-97% of all the water used in the county. Approximately 80% of this water is used for municipal and industrial purposes, and the remaining 20% is used for irrigated agriculture (San Diego County Water Authority, 1991a). Prior to the current drought San Diego had had only limited experience with water use restrictions, and as of February 1991 had so far been spared the severe cutbacks imposed on other communities in the state.

San Diego was an attractive study site for several reasons. First, we had previously established contacts with many of the local water agencies, and we were more familiar with the San Diego region than with other areas of southern California such as Los Angeles or Santa Barbara. Second, San Diego, unlike Los Angeles and Santa Barbara, has few local surface water resources and almost no groundwater resources. Consequently, San Diego is almost completely reliant on water imported from northern California and the Colorado River. The remoteness of these water supply sources from San Diego mean that local weather conditions provide little insight into the current state of water supplies or severity of drought conditions. Instead, the water-using public is largely dependent on the news media for such information.

Finally, among communities in southern California, San Diego County is particularly vulnerable to interruptions in water deliveries. In addition to drought, numerous other hazards potentially threaten the county's water supplies. As shown in Fig. 1, the pipelines carrying imported water into the county are also at risk from damage caused by earthquakes

occurring along any of three major fault systems, or from erosion during floods on the San Luis Rey River and other streams (San Diego County Water Authority, 1991b; Wallace, 1991). Water delivery interruptions can also be caused by breaks in aging or deteriorated sections of the pipelines, as occurred in the Shepherd Canyon area in 1988 (San Diego County Water Authority, 1989) and the Scripps Ranch area in 1990 (Colvin, 1991). Furthermore, abnormally high water demands in one part of the county can cause water shortages or interruptions in other areas, such as the South Bay and Otay Mesa areas near the southern end of the aqueducts. Extreme water demands are typically associated with suppression and prevention of fires during hot, dry Santa Ana conditions.

Because of the scarcity of local supplies, water agencies in San Diego County will rely heavily on water use restrictions to curb demand in the event of interruptions in imported water deliveries (San Diego County Water Authority, 1991b). Therefore, insights gleaned from the effectiveness of water use restrictions during drought may have implications for planning for more serious hazard contingencies.

Water Districts and Media Market Areas. To better understand the impacts of the media on water conservation in southern California, it is necessary to know something of the overlapping geographies of water districts and the local media. The "local news" in San Diego is perhaps more accurately described as a regional news media with a market area encompassing nearly 100,000 square miles including San Diego, Los Angeles, Orange, western Riverside, and western Imperial Counties. In San Diego it is possible to receive eight different television channels, each with at least one daily "local" news program. Half of these programs are broadcast from San Diego and half from Los Angeles. News stories from throughout the five-county region are regularly presented as "local news" even though an individual story may have originated from a location hundreds of miles away from the viewer. The print media is similarly regional in its coverage. The two largest newspapers (in terms of circulation) in San Diego are the *San Diego Union/Tribune*, published locally, and the *Los Angeles Times San Diego County edition*.[1] Water conservation and drought were clearly recognized by the media as regional news stories, and were given similar coverage in both newspapers.

Within this vast media market over sixty federal, state, regional, and local water agencies provide water to agricultural, municipal, industrial, and military customers. During the study period most of these agencies enacted new ordinances, restrictions, conservation programs, water rate schedules, or otherwise made a public response to the drought or its impacts. This flurry of activity provided ample material for numerous news stories that were reported by the regional media. Not surprisingly, we observed that very few people,

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[1] We found that the San Diego County edition of the Los Angeles Times differs only slightly from the editions circulated in Los Angeles. The primary differences appear to be in sports coverage and advertising.

including those in the media, appeared to completely understand the complex hierarchy of water districts, authorities, departments, boards, and commissions that oversee and manage water allocations in southern California. Figure 2 identifies in schematic form the water supply relationships between the major agencies in the Southland area.

The major regional supplier,[2] the Metropolitan Water District of Southern California (MWD), serves most of the five-county region encompassed by the media market area. The MWD supplies water to twenty-seven different member agencies, including the City of Los Angeles and the San Diego County Water Authority (Fig. 3). The MWD contracts for water imported from northern California via the State Water Project,[3] and has fifth-priority rights[4] to water from the Colorado River via the Colorado River Aqueduct.

The San Diego County Water Authority (SDCWA) purchases all of its water from the MWD and, in turn, sells both treated and untreated water to its twenty-four constituent water districts (Fig. 4). The SDCWA is the largest of MWD's customers in terms of the amount of water purchased.[5] Water purchased from MWD and delivered by the SDCWA via the San Diego Aqueducts accounts for about ninety-five percent of all water used in San Diego County. The City of San Diego is the largest of the twenty-four local water agencies, and purchases about 225,000 acre-feet of water annually from the SDCWA, or approximately thirty-seven percent of total SDCWA deliveries to all water agencies in the county.

WATER DISTRICT ACTIVITIES

Water Allocation Cutbacks. In 1991, the California drought began its fifth consecutive year as one of the most severe on record, placing it in a category with the great droughts of 1929-1934 and 1976-1978. Many communities in the San Francisco Bay area and along the central coast had been under some form of mandatory water use restrictions during the past two years. The MWD began the year in Stage 4 of its Incremental Interruption and Conservation Plan (IICP) with twenty percent cutbacks in deliveries to all twenty-seven of its member agencies, increased water rates, financial incentives for agencies that use less than their allotment and surcharges for those that exceed their allotment. By late January,

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[2] and the largest municipal water supplier in the U.S.

[3] allocated by the California Department of Water Resources

[4] after the Imperial, Yuma Valley, Palo Verde, and Coachella Valley irrigation districts

[5] The City of Los Angeles has a larger population, but only purchases about 60% of its water from MWD. The remaining 40% is drawn from its own supplies in the Owens Valley.

with snowpack levels in Northern California at 5-20% of normal and surface water reserves all but depleted (Calif. Dept. of Water Resources, 1991a), communities across the state began fine-tuning emergency plans for reducing water consumption. By early February, conditions were so severe that communities in southern California (including Los Angeles and surrounding cities) that had escaped water use restrictions in previous years began to implement mandatory water use restrictions. On February 12, with forecasts showing no improvement in drought conditions, the MWD Board of Directors declared that Stage 5 of the IICP would become effective on March 1. Stage 5 imposes 31 percent cutbacks in deliveries to MWD member agencies, including the San Diego County Water Authority (SDCWA).

As conditions worsened further during February, other major water suppliers announced their own cutbacks. On February 26, the State of California, citing poor snowpack levels, announced cutbacks of ninety percent to municipal and industrial (urban) users and one hundred percent cutbacks to agricultural users of State Water Project (SWP) water. Many agricultural users and some cities responded by switching to local surface water supplies or groundwater. Between February 26 and March 1 many of the SWP customers implemented emergency conservation plans in response to the cutback announcements. The MWD, one of the largest SWP contractors, responded by announcing unprecedented cutbacks to its member agencies. On March 4, only three days after its Stage 5 cutbacks became effective, the MWD Board voted to implement Stage 6 of the IICP, effective April 1. Stage 6 mandates fifty percent cutbacks and additional rate increases to MWD customers.

On March 2, the U.S. Bureau of Reclamation announced twenty percent cutbacks in deliveries of Colorado River water to its irrigation projects in southern California. Although municipal users in San Diego County were not directly affected by these cutbacks, there appeared to be some public confusion as to how the cutbacks would affect the MWD's Colorado River supplies.[6]

Under MWD's Stage 4 and 5 conditions, the SDCWA stressed to its own member agencies the need for increased conservation and restrictions on outdoor water use. However, final discretion was given to the local agencies to respond as they saw fit. The result was a confusing array of local ordinances and programs ranging from mandatory water use restrictions to voluntary conservation. Some of the mandatory programs were coupled with strict enforcement, while some others were not enforced at all. Some agencies'

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[6] The MWD holds Colorado River water rights that are junior to those of the Bureau-controlled irrigation projects in Imperial and Riverside Counties. Under the appropriative water rights system, senior appropriators receive higher priority than junior appropriators such as MWD. Thus it was felt that cutbacks to the senior irrigators might translate into even greater cutbacks to MWD.

programs were highly visible, while residents of other agencies scarcely knew the programs existed. Notably, the City of San Diego, largest of the twenty-four SDCWA member agencies, implemented a controversial voluntary conservation program. As part of this program, the City established an information hot line, distributed literature, and offered water-saving tips on request. City leaders personally contacted the largest industrial, commercial, residential, and government water users to request reductions in consumption. However during February, conservation within the county did not appear to be working, and the SDCWA paid surcharges for exceeding its monthly allotment from the MWD.

After MWD's announcement that Stage 6 of the IICP would become effective on April 1, water agencies in San Diego County began to seriously consider mandatory use restrictions for all customers. On March 5, the County of San Diego declared a drought emergency and ordered restrictions, effective April 1, aimed at reducing consumption by fifty percent for users in unincorporated areas of the county. On March 14, the SDCWA approved mandatory use restrictions to comply with Stage 6 of the IICP; these restrictions also were to become effective April 1. This action was significant in that it was the first time that uniform countywide mandatory restrictions had been adopted. The regulations restricted lawn and turf irrigation to nighttime hours, all but eliminated other outdoor uses, and placed severe limits on new connections to the water utility.[7] Because the SDCWA has no direct authority to enact local ordinances, water use surcharges in the amount of $200/acre-ft were to be assessed all agencies that did not adopt the proposed restrictions. Between March 14 and April 5, ten of the twenty-four local water agencies in the county revised their conservation plans to comply with the SDCWA restrictions.

Much of the previous two months' conservation activities was rendered obsolete, however, when on February 28, the first of a series of Pacific storms dropped heavy rains on southern California and heavy snows in the mountains of northern California. By the end of March, more than eight inches of rain had fallen in the San Diego area, making it the wettest March on record. Under intense pressure from the public, local politicians, and the media, the SDCWA adopted a "wait-and-see" stance, and delayed implementing restrictions until at least April 15. The deadline was subsequently pushed back to May 1. MWD's Stage 6 went into effect as planned on April 1, but only lasted for ten days. On April 10, with water use already significantly diminished,[8] MWD returned to Stage 5 of the

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[7] The complete text of the proposed regulations is included in Appendix A.

[8] The occurrence of rainfall typically causes a reduction in lawn watering which is reflected as an immediate decrease in a city's seasonal water consumption. After rain ceases, water use will gradually return to its normal seasonal levels (Maidment, et.al., 1985). In San Diego, the timing of rainfall during March was such that a new storm would arrive before water use had time to recover from the previous storm. However, the impact of the March rainfall was likely greater than normal because of the heightened

IICP. Two days later SDCWA announced a rollback to twenty percent cutbacks and voluntary compliance, completely scrapping plans for implementing the countywide mandatory restrictions.

As this report is being written in the fall of 1991, the MWD, anticipating a wet winter, has announced that its conservation programs, including cutbacks, surcharges, and conservation incentives will end as of October 1. Surplus water, held in storage for summer use is now being sold at discount rates to make room for expected winter runoff. However, on October 1, the SDCWA Board of Directors voted to continue their agency's twenty percent cutbacks through September, 1992, with financial penalties for member agencies that miss their target levels by more than five percent.

Public Information Activities. Although the precise timing and frequency of water district public information activities during the study period is not known, some rudimentary data are available on public information expenditures by the regional water supply agencies. It should be noted, however, that the timing of public information expenditures may not accurately reflect the timing of information actually received by the public because of the delay between expenditures and implementation.

According to summary budget documents, the SDCWA spent approximately $190,000 during February, 1991, for drought advertising, telephone drought advisors, and promotion of a Xeriscape video. Expenditures during March totaled $37,500 for printing conservation brochures. In April $5,500 was earmarked for seminars and training courses for member agency personnel and media. In addition, $25,000 was spent on conservation notices for hotels and for Xeriscape brochures. A $175,000 drought public relations campaign was also scheduled to begin in April; this campaign was initially delayed and then scaled back because of the March rainfall and the resulting changes in delivery cutbacks. Additional expenditures planned for May though June totaled $16,000 for seminars, fair booths, and radio messages intended for agricultural water users. Planned expenditures were therefore highest during April; however, two-month planned expenditures for February-March and April-May were approximately equal. Actual expenditures were probably a bit greater during February and March than in April and May because of the delay in the public relations campaign. It should be noted also that SDCWA had earmarked an additional $90,000 during March and April for television advertising related to implementation of the countywide mandatory water use restrictions.

It is interesting to note that in April, the MWD initiated a $3.5 million ad campaign warning the public that the drought was not over, despite the recent rains. This message was deemed so important that an additional $1 million was added to the original $2.5 million budget and the timetable was moved up from June to April (Morain, 1991). The Los Angeles Department of Water and Power likewise committed $2.5 million beginning in

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public awareness of the drought conditions and continued calls for conservation.

April to public service advertising in response to March rainfall and wavering public support for conservation.

The general impression of the research team was that very little public information activity was evident during the first and second trips to San Diego in March and April. However during the third trip in June, there was a noticeable increase in public service advertisements in the newspaper, billboards, radio messages, and notices in hotels and restaurants. Few messages were observed on television during any of the trips. This increased level of activity in June was probably intended to encourage conservation through the dry summer months, but was obviously too late to influence the critical period of conservation in February and March.

MEDIA ACTIVITIES

Frequency and Timing of Drought and Conservation Stories. The number of newspaper items[9] in the *San Diego Union/Tribune* in which the drought or water conservation were mentioned was tallied for each week from February 3 to May 4, 1991 (Table 1). The San Diego *Union/Tribune* was selected rather than the *Los Angeles Times* because of the more complete collection of the *Union/Tribune* available at local libraries. However, we observed that story content and timing for both the *Times* and the *Union/Tribune* were almost identical. Only one edition of the *Union* or *Tribune* was analyzed on any given day.

As indicated in the table, the number of items peaked during the third and fourth weeks of March, coinciding with media responses to heavy rainfall and the resulting flurry of water district announcements modifying their conservation programs. Also of note are the numerous items during the weeks immediately before and after March 1, when many local water agencies began announcing water use restrictions in response to MWD's cutbacks. Drought and conservation articles tended to be placed in one of three locations in the paper: (1) on the front page, (2) on page A3, the page designated for statewide drought coverage, or (3) on pages B1 through B3 in the City/Local section. Irregular feature articles under the common bannerhead "The California Drought" were occasionally to be found in other sections. The frequency of newspaper items for periods prior to February 3 and after May 4 was observed to average about one item per week. It should be noted that both newspaper and television reports were dominated by coverage of the U.S.-Iraq war during the early part of the study period,[10] leaving less room for drought and conservation stories.

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[9] Articles, advertisements, editorials, or letters

[10] Especially during the week of February 17-23, when the major U.S. ground offensive, involving quite a large number of U.S. Marines based in San Diego, took place.

Television coverage followed patterns similar to the newspaper items. Film logs were obtained from two local news stations, KNSD channel 7 and KFMB channel 8. The KFMB log was the most complete, recording the titles and durations of all drought, water, and conservation stories aired during the study period. Because we observed little difference between coverage on different stations, only the analysis of the KFMB log is presented here (Table 2).

The number of stories and total duration of coverage peaked in the first and second weeks of March and again in the fourth week of March. A disproportionate number of stories focused on only a few highly publicized events, including the SDCWA board meeting on March 9 and the "Southern California Water Summit" described in the next section. Drought and conservation coverage on television was observed to be clustered within each newscast as a group of two to five consecutive stories. The position of these story groups within the newscast varied considerably from station to station and broadcast to broadcast (e.g., 6PM news versus the 11PM news).

The general impression of the research group was that both newspaper and television stories tended to focus on official announcements and statements by public officials. As will be described in the next section, most such statements were reported without question and with little synthesis, analysis, or editorial comment.

Highlights of Media Activities. Most of the water district actions described previously received the attention of the news media. The major cutback announcements covered by television or print media are summarized in Table 3. In many cases the media "double covered" these events, running stories both before and after each announcement, resulting in a large volume of information being sent to the public.[11] It is possible that the numerous reports of cutbacks and restrictions of various degrees of severity contributed to the confusion and ambiguity expressed by many respondents to our telephone surveys.

In addition to water district announcements, the news media focused on comments made by highly-visible public figures such as the Governor, mayors, and city council members. It appeared that those public figures with the greatest potential for generating controversy received the most attention. One of the more colorful public figures was Maureen O'Connor, Mayor of San Diego and outspoken critic of mandatory water use restrictions. Mayor O'Connor made good use of her influence in the media to denounce

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[11] The "Before" stories called attention to the fact that an announcement was to be made the following day, and usually attempted to predict the content of the announcement (e.g., "MWD will announce cutbacks of 50% at a news conference scheduled for tomorrow morning"). The "After" stories simply reported the announcement as it was presented. On more than one occasion, the predictions made in "Before" stories proved to be incorrect.

mandatory restrictions and to promote her own voluntary conservation plan, despite the fact that most other communities in the county supported some form of mandatory restrictions. At a SDCWA board meeting on March 7 covered extensively by the media, she attacked plans for implementing countywide mandatory restrictions. She argued that restrictions would be detrimental to the economy, would increase the risk of fires, would be unfair to military personnel returning from the Persian Gulf, and would be unnecessary because the drought would soon be over[12].

In late February, officials from Los Angeles publicly censured Mayor O'Connor's voluntary conservation program after San Diego County failed to meet MWD's conservation targets during January and February. Los Angeles Deputy Mayor Michael Gage criticized San Diego for not implementing mandatory restrictions as Los Angeles had done some months previous. Mayor O'Connor responded by citing statistics showing that San Diego had reduced consumption during the last week of February by thirty-five percent over the same period during 1990, while Los Angeles residents had been required to reduce consumption by only ten percent. Such statistics, while essentially valid, were frequently stated and reported in a manner that encouraged misinterpretation. For example, heavy rains fell during the last week of February, 1991, while no rainfall was recorded during the same week in 1990, making a year-to-year comparison misleading. Further, during the week cited by O'Connor, Los Angeles, though *required* to reduce consumption by only ten percent, actually achieved reductions of about thirty-four percent. Given typical margins of error in such calculations, there is no statistical difference between thirty-five and thirty-four percent reductions. It was interesting to observe that such claims made by public officials were reported *without question* by the media. Surprisingly, even Los Angeles officials offered little in the way of rebuttal to O'Connor's claims.

On March 13, Mayor O'Connor and Mayor Tom Bradley of Los Angeles met face-to-face in what was dubbed by the media as "The Southern California Water Summit" to discuss mutual differences in conservation policies. Despite high expectations created by advance press coverage, the meeting lasted a mere half hour, and resulted in little new information.

Later during March, the media again turned its attention to Mayor O'Connor when the San Diego Water Utility released its "top 100 water users" list. The list included, notably, Mayor O'Connor (no. 93, with 3248 gals/day average[13]) and Helen Copley, the publisher of the *San Diego Union* (no. 1 with 10,203 gals/day), a noted opponent of

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[12] For a few weeks following the meeting, the media seemed to delight in analyzing the Mayor's mysterious prediction regarding the drought's demise. Numerous local "weather experts" were called upon by the media to verify or refute O'Connor's claims.

[13] More than ten times the average per capita water use for the city.

mandatory cutbacks. At about the same time, California Governor Pete Wilson (O'Connor's predecessor as mayor of San Diego) was also cited by the media for high water use at his home in Sacramento. San Francisco's mayor, Art Agnos, was similarly cited. These news stories, more than any others concerning cutbacks, conservation, and drought seemed to stick in the minds of the public, and seemed to reinforce the widespread opinion that the local and state governments were not strongly committed to conservation.[14]

Perhaps the most notable and unanticipated news event was the heavy precipitation during March, dubbed the "March Miracle" by Mayor O'Connor and echoed by the press. The media responded to the unexpected wet weather with typical enthusiasm, focusing on isolated areas of the state receiving the most extreme rainfall amounts and impacts. Stories were run about new threats to the county's water supply from flooding streams and consequent erosion of the SDCWA pipelines. Within a single day following the first rain storm, stories were aired re-examining the need for water use restrictions, and questioning previous predictions regarding the longevity of the drought. Mayor O'Connor quickly announced to the media that her own predictions had been realized and that the drought was over, despite more cautious messages being voiced by water managers across the state. Such stories became more frequent as successive storms arrived during the month.

The rain also led to a noticeable change in the tone of articles and editorials critical of water conservation, as if the rain had in some way vindicated critics and legitimized their claims. Los Angeles writer John Dentinger, in a nationally-published editorial (Dentinger, 1991), argued that water officials were resisting calls to relax water use restrictions because they feared the collapse of the "water conservation bureaucracy" on which their jobs and their power depended. In the *Los Angeles Times*, Katz (1991) reported that the wet weather had caused many conservation workers at the Los Angeles Department of Water and Power to fear that their jobs might be terminated. He also noted that every attempt by the city during the past two years to launch a media campaign to promote conservation had occurred on days of heavy rain at home or heavy snows in the mountains. Morain (1991) described how the rains and resulting attitudes had frustrated water agencies' advertising campaigns intended to encourage continued conservation. In the *Wall Street Journal*, USC business professor Mark Zupan sharply criticized water agencies for using "strong-arm tactics" (i.e., water use restrictions) to curb demand in lieu of more equitable pricing incentives (Zupan, 1991).

In response to political pressure and criticism in the media, water agencies began rethinking plans for additional cutbacks, despite the fact that the rains had only partially replenished water supplies in northern California. During the last two weeks of March, announcements were made effectively delaying implementation of water use restrictions originally planned for April 1. By the first of April, however, many agencies had already begun announcing rollbacks to earlier conservation levels. Again, media "double coverage"

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[14] Based on commentary provided by respondents to our field surveys.

of water agency announcements created the potential for increased confusion on the part of the public. This situation was made especially confusing in several instances when the rollback announced by water agencies proved to be greater than that predicted by the media in its "before" reports.

In summary, during the study period the southern California news media focused almost exclusively on announcements and statements made by government officials. As a result, reporting often lacked any perspective or analysis other than that provided by the government officials themselves. Public figures deemed to be the most entertaining were given the most coverage. While water agency announcements were reported faithfully, the sheer number of such announcements may have contributed to the general sense of confusion that seemed to prevail.

SURVEY RESULTS

Telephone surveys of residential water users in San Diego County were completed during both the March and April field trips. Details of methods used are reported in Shaw (1991a,b). Because of limited personnel, time, and resources the sample sizes of the surveys are fairly small -- approximately one hundred complete responses were received out of about three hundred phone numbers called. Further, rapidly changing conditions forced us to modify survey questions several times, first in response to the March rainfall, and then in response to changes in conservation programs.[15] The low number of responses to any given survey question limits the statistical validity of numerical results.

It should be pointed out that other studies have called into question the *methodological* validity of telephone surveys, and of water use surveys in particular. For example, Postman (1985) argues that surveys evoke *emotions* that tend to change from day to day, rather than firmly-held opinions or beliefs. Indeed, the rapid, controlled format of most surveys does not lend itself to extraction of thoughtful, original ideas. Other studies (Syme, et.al., 1991; Boland, et.al., 1990) have suggested that survey respondents' professed beliefs about water conservation and water use may have little connection with their actual water consumption. The reason for this seemingly contradictory behavior is that most people simply have no idea how much water they actually use, regardless of, for instance, whether they support or oppose mandatory conservation. As will be described subsequently, the respondents to our surveys were no different.

Despite these important weaknesses, our surveys were not without benefit. One of the unanticipated results of the surveys was that many respondents remained on the phone for extended periods of time, discussing and, in some cases, arguing conservation and water management issues. From these discussions, as well as the results of the surveys, we were

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[15] The various versions of the survey question forms are included in Appendix B.

able to get a general sense of levels of awareness, key sources of information, methods of conserving water, and attitudes toward water management. However, because of the uncontrolled nature of such discussions and the small sample size of the surveys, quantification of the results is difficult. Therefore, the observations that follow are intended to be qualitative, and are useful primarily in providing context to our interpretations and hypotheses regarding media impacts.

Through the surveys, we learned that most respondents (90%) were aware that some form of conservation program was in effect in their community. However, a surprisingly large number of respondents (55%) were not sure of (or cited incorrectly) the form of conservation (mandatory or voluntary), the type of restrictions in effect, or the amount by which residents were being asked (or required) to reduce consumption. This result agrees with the observations of Turner (1980), who notes that the public often forms an overall impression of news events, but seldom is able to recall details of media predictions and announcements.

A significant number of respondents (22%) indicated that they lived in apartments and either did not pay their own water bills or had no discretionary water use (e.g., lawn watering) that could be reduced.[16] Many residents of single-family homes had eliminated lawn watering (40%), but most indicated that this was because of the rain rather than any particular regulations or restrictions. When asked about actions they had taken to reduce consumption, the most common answers were: taking shorter showers (54%), washing full loads of dishes (48%), not watering lawn (40%), washing full loads of laundry (40%), and using low-flow plumbing fixtures (38%). Of these, the reduced lawn watering probably had the most impact on aggregate water use.[17] However, most of the respondents (70%) had no idea how much water they were actually saving through their conservation efforts. Similarly, while an overwhelming majority (92%) supported conservation, only a few respondents (<15%) could even roughly estimate how much water they used in a typical billing period, or during the most recent billing period.

Most respondents (58%) indicated that television news had provided the most useful information regarding the drought and conservation programs, followed by newspaper articles (22%), public service messages on any medium (11%), and radio news (9%). In March, respondents reported being quite saturated with information, with most (85%)

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[16] However, in a few cases respondents noted that apartment managers had actually imposed more stringent restrictions than had the city.

[17] It is well established that lawn watering in semi-arid and arid climates accounts for the majority of all seasonal water use in urban areas (Howe and Linneweaver, 1967; Anderson, et.al., 1980; Maddaus, 1987; Maidment, et.al., 1985; Shaw and Maidment, 1987b; 1988). In southern California this amount may be as high as 60-70 percent of the total annual water use (Shaw and Maidment, 1987a).

indicating that they read or heard one to four drought or conservation news stories per day. In April, most respondents (56%) indicated that the frequency of news stories was about the same as in March.

Respondents listed the rainfall (25%), Mayor O'Connor's high water use (14%), and the cancelling of planned fifty-percent delivery cutbacks (11%) as the news events that most influenced their opinions regarding conservation. However, many respondents (25%) indicated that news stories had not influenced their opinions or behavior at all. Likewise, many respondents (26%) indicated that Mayor O'Connor was the public figure that most influenced their opinions (both positively and negatively). But most (52%) claimed not to be influenced by any public figures. There was a noticeable change in attitude concerning the Mayor between March and April. In March, many people openly supported O'Connor's efforts to promote voluntary rather than mandatory conservation. However, by April most respondents seemed to be displeased or disgusted with her exorbitant home water consumption. Many respondents' unsolicited comments were highly critical of the way the local and state governments had handled the drought, and many believed that leaders lacked the commitment needed for effective conservation. Despite these views, however, it was interesting to hear many people express ideas using *exactly* the same wording that the Mayor or some other public figure had used in recent television news interviews. This observation echoes those of Robinson and Levy (1986) who note that "public awareness and comprehension often bears a striking similarity to journalistic encoded reality."

Finally, from unsolicited comments and answers to some of the survey questions, it appeared that at least half the respondents did not truly understand the hierarchy of water suppliers in southern California. There was much confusion concerning whether MWD, SDCWA, the City of San Diego, the State Water Project, some other entity or combination of entities actually supplies water to San Diego County. Many had only vague knowledge of the current state of the region's water supplies. This lack of understanding and the numerous cutback announcements reported in the media may partly explain the confusion regarding which conservation programs were actually in effect.

TIME SERIES ANALYSIS

Water use time series were analyzed for water agencies in southern California to estimate the impacts of conservation during the study period. Daily water use time series were analyzed for six water agencies using a simple transformation to make each series dimensionless. The dimensionless form was used to facilitate comparison of water use by agencies or cities of different sizes. Weekly water use time series were analyzed only for the cities of San Diego and Los Angeles. In the weekly analysis, a time series model of unrestricted water use was developed and compared with observed water use to estimate the effectiveness of conservation. Each of these analyses are described separately below.

Analysis of Daily Water Use. Six water agencies were chosen for analysis of daily water use: Sweetwater Authority, Helix Municipal Water District, City of San Diego Water Utilities, the City of Escondido, and the SDCWA in San Diego County and the Los Angeles Department of Water and Power in Los Angeles County. An additional water agency, the City of Bakersfield in Kern County, was used as a control case. Bakersfield does not receive water from MWD and so was not subject to cutbacks. However, Bakersfield, although located several hundred miles to the north, is subject to roughly the same weather as the study agencies.

Daily water use data were obtained from the six study agencies and Bakersfield for the period January 1, 1990 to June 1, 1991. Data for the SDCWA are actually "average" or 2 PM daily combined flows in the agency's five aqueduct pipelines. Los Angeles water use data are likewise calculated as daily flow totals. Data for all other agencies represent the daily total output from all treatment plants plus any treated water deliveries (by the SDCWA) to the agencies. Time series plots of water use for the six study agencies are shown in Figs. 5-10. From these figures it is apparent that the patterns of water use are remarkably similar despite large differences in the magnitudes.[18]

Each water use time series was made dimensionless by applying the following transformation (Shaw and Maidment, 1987a):

$$\text{Dimensionless Water Use} = [W(t) - B(t)] / [Smax - B(t)]$$

where W(t) = observed water use on day t, B(t) = estimated base water use on day t, and Smax = estimated peak seasonal water use. The base and peak seasonal use are estimated as the daily average of the minimum (January) and maximum (August) months' water use, respectively. Dimensionless water use in 1986 (the last year prior to the beginning of the current drought) for four of the study agencies (Escondido, Helix, SDCWA, and San Diego) are plotted together in Fig. 11. The remarkable agreement among the series shown in Fig. 11 is largely the result of the similar weather patterns affecting each agency. Large drops in water use are caused by the occurrence of rainfall. The large spike at approximately day 250 is caused by hot, dry Santa Ana conditions that occurred on that day. The remaining day-to-day fluctuations can be considered random noise (Maidment, et.al., 1985).

During the study period from March 1 to May 1, 1991, each of the study agencies had a slightly different form of conservation program in effect. As discussed previously, the City of San Diego had implemented a highly-visible voluntary conservation campaign. Both Helix and Escondido had implemented mandatory restrictions on paper, but were still relying on voluntary compliance to achieve a target level of thirty-one percent reductions. Sweetwater Authority had implemented the second stage of a mandatory conservation

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[18] 1 MGD = 1 x 10^6 gallons per day, which is equivalent to an average daily flow rate of 1.55 cfs (cubic feet per second).

program that included reduced hours for lawn watering. However, according to Authority officials the restrictions were not strictly enforced. The SDCWA, which supplies water to San Diego, Helix, Escondido, and Sweetwater, was subject to thirty-one percent cutbacks in deliveries from MWD -- however, during March and April, SDCWA officially asked for only voluntary compliance with target reduction levels. In any case, water use data for SDCWA is largely determined by the water use of the City of San Diego, its largest customer. By March 1, Los Angeles had already implemented an aggressive mandatory program with strict enforcement of restrictions. The program was intended to achieve reductions of at least ten percent. Unlike the other agencies, Bakersfield did not implement any form of conservation, either mandatory or voluntary.

Dimensionless water use during 1990-91 is shown for Bakersfield in Fig. 12 and for the six study agencies in Fig. 13. In Fig. 13 the reduced consumption during the study period is readily apparent. Note however that in Fig. 12, although the overall pattern is similar to those of the study agencies, the reduction during March 1990 is much less evident. In Fig. 13 there are three distinct water use traces during the study period (marked [1], [2], and [3] in the figure). The upper trace ([1]) corresponds to Helix and Escondido; these agencies achieved reductions that are little different from those observed in Bakersfield, where there was no conservation. The middle trace ([2]) is Sweetwater Authority. The lower trace corresponds to SDCWA, the City of San Diego, and Los Angeles. The relative differences in consumption represented by these traces appears to correspond to the level of "visibility" of the conservation programs of the four local agencies and Los Angeles (and SDCWA closely follows the City of San Diego as expected). Helix and Escondido did not expend much effort to promote or enforce conservation, and apparently achieved only minimal reductions. Sweetwater implemented and enforced (to a certain extent) mandatory restrictions, but did not generate the media attention of San Diego or Los Angeles.

Although all areas of the media market were subjected to the same media coverage, one could argue that San Diego and Los Angeles were the most highly publicized programs (particularly given the conflicts between the mayors of the two cities). That the levels of reduction achieved by such completely different programs would be so similar is of special significance. This result suggests (possibly) that the similar levels of publicity and media coverage given Los Angeles and San Diego produced similar levels of reductions, despite the differences in the cities' approaches to conservation. However, the results are far from conclusive. Because of the rainfall in March, it is difficult to separate the effects of conservation from the normal reduction caused by rainfall. The reduction levels achieved by Bakersfield are assumed to be entirely the product of the rainfall -- and are consistent with the observation that rainfall rarely drives water use below winter base levels (i.e., the zero level in the dimensionless plots), while conservation programs in other U.S. cities have been shown to cause reductions significantly below the base (Shaw and Maidment, 1988). Analysis of daily data for each of the study agencies from 1985-1991[19] reveals that the

[19] 1983-1991 for Los Angeles

lowest values of dimensionless water use occurred during the study period from March to April of 1991; in most other years, dimensionless water use did not fall below -0.6. However, in 1986, with no conservation in effect, dimensionless water use for several of the agencies fell almost to -1 during a period of heavy rainfall. It should also be noted that the initial drop in water use observed in each time series during the study period occurred on February 27, the day after the first heavy rain storm. The various cutbacks and conservation programs did not become effective until March 1, two days later.

Analysis of Weekly Water Use. Time series models were developed for unrestricted weekly water use in San Diego (city) and Los Angeles using historical data from 1985 to 1989. Quantitative estimates of conservation reductions were obtained by comparing model-simulated water use with observed water use during the study period.

The water use time series model is based on three main assumptions:

(1) Water use consists of constant or slowly-varying base component representing winter or "indoor" water use and weather-dependent seasonal component representing summer or "outdoor" water use;

(2) In the absence of rainfall, water use will attain a maximum or "potential" level that is solely a function of prevailing temperatures;

(3) The occurrence (rather than the amount) of rainfall produces a decrease in water use during the week it occurs.

Each of the above assumptions are consistent with previous research by Maidment, et.al. (1985) and Shaw and Maidment (1987a) for daily water use and Miaou (1990) for monthly water use.

In equation form the model is written as:

$$W_t = P_t + R_t + N_t$$

where W_t = water use in week t, P_t = potential water use in week t, R_t = rainfall effect in week t, and N_t is a correlated random noise term. The potential use is modeled as a two-harmonic Fourier series function of the temperature during rainless periods (Shaw and Maidment, 1987a; Miaou, 1990). The rainfall effect is defined as (based on Miaou, 1990):

$$R_t = k*NR_t*P_t$$

where NR_t = the number of rainy days during week t, and k is a coefficient to be estimated. N_t is assumed to be a first-order autoregressive noise term. Short-term fluctuations in temperature were also hypothesized to influence water use (e.g., Maidment, et.al., 1985). However, for the San Diego and Los Angeles data this effect appears to be limited to

isolated weeks during severe Santa Ana conditions.

The seven unknown model parameters (five Fourier series coefficients for P_t, one autoregressive correlation coefficient for N_t, and k in the rainfall function) are estimated using nonlinear least-squares regression. Further details of model development and results of parameter estimation are given by Shaw and Henderson (1991). Model fit with the observed data for the estimation period (1985-1989) was extremely good: $R^2 = 0.97$ for San Diego and 0.95 for Los Angeles. Such good fit is not unusual for water use in arid western states, as shown previously by Shaw and Maidment (1987a) and Maidment and Miaou (1986) using similar modeling techniques for daily water use in southern California and Texas.

Figures 14 and 15 show model-estimated and actual (observed) weekly water use for each city during the period from January 1, 1990 to May 1, 1991. Conservation reductions are calculated as the average of each week's difference between modeled and observed water use.[20] A similar technique was employed by Shaw and Maidment (1988) to determine reductions caused by water use restrictions in Corpus Christi, Texas.

Results of the analysis of Los Angeles and San Diego are presented in Table 4. In the table, estimated reductions (expressed as percentages) are followed by their standard errors (also expressed as percentages) in parentheses. For example, during Summer 1990, it is estimated that Los Angeles reduced consumption by nine percent (plus or minus four percent) over normal (1985-1989) conditions. Comparing the reduction estimates with their standard errors for the spring and summer of 1989 and 1990 and for early 1991, it is seen that conservation during those periods was only marginally effective at best.[21] However, during the study period Los Angeles and San Diego achieved thirty-four percent and thirty-one percent reductions respectively. Given the magnitude of the standard errors of these estimates, there appears to be little difference in the performance of the two conservation programs. Although the models accounted for the effects of rainfall, there were few storms comparable to those of March, 1991, in the 1985-1989 estimation data set. Thus it is possible that some of the estimated reduction would have been achieved even without conservation.

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[20] This procedure is different from the procedure used by the water agencies to calculate reductions. The water agency calculations compare observed water use with water use during the same week in a base year, usually 1990 or 1986. The latter procedure does not account for differences in weather between the current and base years.

[21] When the standard error is greater than or equal to the estimate, that estimate is not considered statistically significant.

CONCLUSIONS AND RECOMMENDATIONS

Because of the unusual field conditions (i.e., unprecedented drought broken by unprecedented rainfall), there can be no firm conclusions drawn from the results of this study. It is clear to us that the relationships between media reporting and water conservation are not trivial and are difficult to fathom from telephone surveys and interviews.

Indeed, even assessing the impact of an individual news story can be ambiguous. Frequently, the same newspaper article or television report can be seen as either encouraging or discouraging conservation, depending on the perspective of the observer. For this reason, many media researchers have argued that news media messages tend to reinforce pre-existing beliefs rather than to directly influence public attitudes (Ledingham and Masel-Walters, 1986; Spencer, et.al., 1990). Other researchers have described the public as media message *consumers* who select only those messages that are consistent with their personal needs, backgrounds, attitudes, and beliefs (Ledingham and Masel-Walters, 1986). It has been suggested that the news media may actually tailor or *market* their messages according to what they perceive to be the prevailing public attitudes (e.g., Postman, 1985).

Another central problem in determining media impact is that the public's stated beliefs and attitudes seem to have little correlation with their actual behavior regarding water use (Syme, et.al., 1991; Boland, et.al., 1990). As suggested by the results of our surveys, the public is largely unaware (even in a qualitative sense) of how much water they use and how much water they save through their conservation efforts. This observation seems to hold true regardless of an individual's attitudes toward conservation. Recommended future research might include additional surveys and more detailed content analysis of media reports (such as employed by Spencer, et.al., 1990) to shed more light on how media messages concerning conservation are processed in such a context.

Such conclusions as we are able to draw from the study are largely based on circumstantial evidence. For instance, the two communities with the most highly publicized (and hotly contended) conservation programs, San Diego and Los Angeles, appear to have been the most successful, each achieving approximately thirty percent reductions from normal conditions. Water use in each city dropped significantly below the winter base levels and was at its lowest level since at least 1985. Significantly, San Diego was apparently able to achieve those reductions using only voluntary conservation -- research had previously shown voluntary conservation in large cities to be ineffective (e.g., Shaw and Maidment, 1987; 1988; Maddaus, 1987). Yet the reductions in San Diego and Los Angeles came during a period of unprecedented wet weather that probably would have significantly reduced consumption even without a formal conservation program.

One of the more pervasive impressions of the situation in San Diego County during our field trips was the apparent high level of confusion concerning the timing and

applicability of cutbacks and restrictions. In part, this confusion seemed to stem from a general lack of knowledge about the agencies that supply water to the county and the relationships among those agencies.[22] As the numerous cutback announcements were reported by the media, many of the public may not have known which cutbacks or restrictions were applicable to a given community. This problem was perhaps compounded by typical modes of processing media messages in which the public forms general impressions of a situation, but is unable to recall details with certainty (Turner, 1980). As a first step to reducing such confusion in the future, we recommend that community and environmental groups, local governments, and the water agencies themselves make a greater effort to educate the public about how the various water agencies fit together and interact.

Many municipal water agencies in California also recognized the public confusion caused by mixed messages in news media markets that include water districts with different conservation goals and programs. The California *Urban Drought Guidebook* cautions that "it is important that the customers hear consistent messages from water suppliers in [a] region, particularly when they are in the same media markets" (California Dept. of Water Resources, 1991b). With the events of San Diego County clearly in mind, the association of California Urban Water Agencies recently adopted a similar position urging a unified voice in media announcements. It is unfortunately true that large interconnected water systems like those that serve southern California require such monolithic, standardized relations with the media and the public. Yet with the media already dangerously biased towards government and corporate viewpoints, an increasingly uniform message may tend to inhibit what little debate still exists concerning long-term solutions to southern California's water problems.

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[22] This lack of knowledge is not helped by the historic tendencies of some water agencies to keep a low public profile. One television news report on March 9 (the day of an important SDCWA board meeting debating countywide mandatory restrictions) stated that most people had never heard of the San Diego County Water Authority, and subsequently presented an overview of the agency and its key personnel. Notably, however, the story did not contain any information about the relationship of SDCWA to the MWD or to the local agencies in San Diego County.

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