Municipal Water Demand and Conservation: Western Water Assessment Studies

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This article summarizes some of the significant findings of recent WWA studies on municipal responses to drought in Colorado, including a publication in the Journal of the American Water Resources Association and a new report issued by WWA, both available on the WWA webpage (see the end of this article).

Introduction

Since the 2002 drought municipal water providers in Colorado's Front Range have utilized a variety of mechanisms to cope with water shortages, including short-term outdoor watering restrictions, formal drought plans, and longer-term water conservation planning. Water availability will be an ongoing concern throughout the region as the population continues to increase. Further, drought has been more common in past centuries than the past 100 years, and coupled with population growth, suggests that water shortages may be exacerbated in the future (see Woodhouse and Overpeck 1998). Consequently, these coping mechanisms are important components of water management and planning. As part of its mission to "identify and characterize regional vulnerabilities to climate variability and change" the Western Water Assessment (WWA) has undertaken several studies of the municipal response to drought.

2002 Municipal Response to Drought

The severity of the 2002 drought exposed the vulnerabilities of many water supply systems under extreme drought conditions within the state of Colorado. WWA examined drought response strategies of eight municipal water providers including Aurora, Boulder, Denver, Fort Collins, Lafayette, Louisville, Thornton, and Westminster (Kenney et al. 2004). Four of the eight surveyed municipal water providers restricted lawn watering to once every three days, whereas three water providers limited lawn watering to twice a week. Finally, Lafayette implemented the most severe restrictions, limiting lawn watering to only once a week.

Daily water use for the study period May 1 – August 31, 2002 was compared to water use from 2000 and 2001 as well as to the "expected use" of water in summer of 2002 absent any water restrictions. The first method compares daily water use (i.e. deliveries) during periods of water restrictions to that of water use during the same time period from previous years. The second method compares daily water use under imposed water restrictions to what researchers expected use would be without water restrictions, given the same precipitation and temperature conditions. Savings were also computed on a per capita basis to account for the impact of population growth.

This study found that during mandatory water restrictions, water use savings measured in expected use per capita ranged from 18-56%, about 4-6% greater than using direct comparison of water use between years. Mandatory water restrictions were far more effective than voluntary water restrictions that only saw a reduction of 4-12%. Consistent with previous drought management case studies it was also found that the tougher water restrictions were, the higher the water use savings.

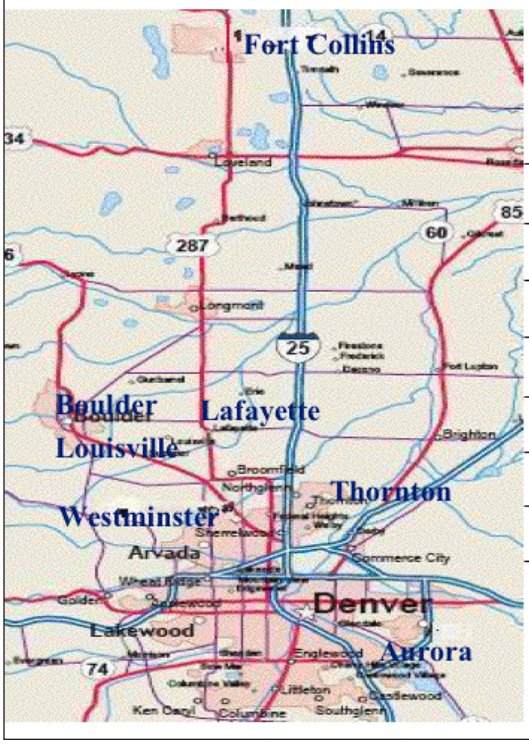
It is evident from this study that mandatory outdoor water restrictions can be an effective short-term drought coping mechanism. However, the success of the 2002 water restrictions might have been partly attributed to the urgent, emergency nature of the situation. Nevertheless, the discussion of short-term restrictions serves as an appropriate background to transition into how municipal drought planning incorporates climate information to shape management strategies.

Drought Management: The Incorporation of Climate Information

Drought planning at the municipal level is becoming more common since the onset of drought conditions in 2002. In a recently released report, WWA conducted a follow-up study of the eight municipal water providers featured in the 2002 drought effectiveness study along with twenty-one other major Front Range providers to determine the prevalence of formal drought planning as contrasted to the more ad-hoc watering restrictions imposed in 2002 (Klein and Kenney 2005). The study found that 13 out of the 29 water providers had a drought plan defined as a document that describes an agreed upon process to assess periodically water supply conditions and the options for responding to emerging drought based on pre-defined deficiencies or triggers. Eight of these 13 plans included drought indicators and/or triggers.

Klein and Kenney found that many of these eight drought plans used climate information as a key component in assessing the severity of a drought. The types or sources of climate information used include: streamflow reports, streamflow forecasts, snowpack reports, weather reports, climate forecasts, drought

Water Savings from 2002 Lawn Watering Restrictions



Municipal Water Provider	*Actual Savings Over the Entire Study Period (acre feet)	Lawn Watering Restrictions Mandatory (M) & Voluntary (V)
Aurora	2,842 to 5,522	M: Every 3 days
Boulder	2,805 to 3,287	M: Twice a week
Denver	9,528 to 18,768	M: Every 3 days
Fort Collins	1,254 to 2,933	M: Twice a week
Lafayette	1,198 to 1,393	M: Once a week
Louisville	1,031 to 1,141	M: Twice a week
Thornton	-855 to 1,112	V: Every 3 days
Westminster	460 to 1,844	M: Every 3 days

*Variation in water use savings is due to different methods of calculation

indices such as Palmer Drought Severity Index (PDSI) and the Surface Water Supply Index (SWSI), and soil moisture reports, most of which water providers find on the internet. Municipal water providers use this information to assist them in determining whether to implement drought restrictions and, if so, at what level of severity.

However, climate sensitive drought triggers and indicators only represent a portion of the water management puzzle. Professional judgment and experience is imperative in translating indicators and triggers into drought management action. As one water manager explained, professional judgment is necessary because a simplified trigger cannot capture all of the elements water managers may evaluate and weigh when projecting water supply. (Klein and Kenney, p. 9) The incorporation of accessible climate information with professional judgment is an ideal partnership when enacting a successful drought management plan.

Aurora Water Demand Management Study

Aurora Water has implemented a variety of demand management strategies over the past four years that collectively have produced a significant reduction in municipal water demand. In an effort to better understand this trend WWA researchers teamed up with Aurora Water last year to analyze the effectiveness of these and other policies using household water use data from the past eight years. To date, this analysis has focused on the residential sector which showed the highest level of response. Some of the questions the study is addressing include:

1. Aurora has implemented a variety of pricing structures and mandatory watering restrictions over the past four years to curb demand. How have these policies impacted monthly household water demand? Is there an interaction between price and non-price policies? Are certain types of customers more responsive to different drought policies than others?

The preliminary results suggest that the magnitude of the response of each household to both price changes and outdoor restrictions was highly dependent on the "type" of user. As could be expected, "high-end" users – those with a high outdoor water demand - were more responsive to outdoor watering restrictions than "low-end" water users who were primarily indoor water users. On average, restrictions reduced the demand of high-end water users by over 51% while reducing the demand of low-end users by less than 8%. Similarly, high end water users were more than twice as responsive to price increases in the absence of restrictions. However, low-end users were more responsive to price increases when restrictions were in place, presumably

because high end users had already cut back their use in response to restrictions.

These results indicate that the future effectiveness of demand management policies is dependent on whether small lots with low intensity water demands dominate new growth, in which case we can expect those consumers to behave more in line with "low-end" consumers.

2. Aurora has distributed devices (Water Smart Readers) that permit individual households to track their real-time water use, providing an unprecedented opportunity to evaluate the relationship between that kind of information and customer demand. How does having a Water Smart Reader (WSR) impact monthly household water demand?

Preliminary findings suggest a modest increase in water usage by households with a WSR. Despite an increase in use, these households were less likely to consume in the highest price block once they were able to track their use with the WSR. Together, these two points suggest that households are better able to modify their use to match the goals established by their water budgets when they can monitor their water use on a daily basis. However, it should be noted that this was not a random sample since it includes only households that chose to purchase Water Smart Readers.

3. Aurora has provided rebates for purchases of items such as low flow toilets and certain irrigation technologies. Have these rebates had an impact on residential water demand?

On average rebates for low-flow toilets reduced demand by 10-17%. Estimating the effect of the irrigation technology rebate program on household demand is more complex. This is because the installation of, for example, a new sprinkler system is often accompanied by other changes that may increase water use, such as the installation of a new lawn[1]. Thus, participation in the irrigation technology rebate program led to slight increases in use in some cases and slight decreases in others. This does not suggest that these programs will lead to an increase in residential demand but rather that the available data do not allow us to control for those other changes that might accompany participation in the irrigation technology rebate program. This is thus an area that requires more research[2].

Potential expansion of the study may include surveys of individual households about their decision making processes regarding outdoor water use. Researchers hope to include additional municipalities in their future work.

References:

Kenney, D., R. Klein, and M. Clark, 2004. Use and Effectiveness of Municipal Water Restrictions During Drought in Colorado. Journal of the American Water Resources Association, February 2004, 77-87. http://wwa.colorado.edu/admin/publication_files/resource-296-water_restrictions_jawra.pdf

Klein, R. and D. Kenney, 2005. Use of Climate Information in Municipal Drought Planning in Colorado. Western Water Assessment Report. http://wwa.colorado.edu/admin/publication_files/resource-2401-drought_planning_report.pdf

Woodhouse, C.A. and J.T. Overpeck, 1998. 2000 Years of Drought Variability in the Central United States. Bull. Amer. Met. Soc. 79(12), 2693 – 2714, December.

1 This is less likely to be the case for participation in the low-flow toilet program where households can only apply for a rebate if the new toilet they purchased is used to replace a pre-existing toilet.

On the Web

- Western Water Assessment Home Page: http://wwa.colorado.edu