Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

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Water Budget Rate Structure: Experiences from Urban Utilities in California

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Executive Summary

Definition of the analysed EPI and purpose

The Economic Policy Instrument to be analysed in this report is the so-called The Water Budget Rate Structure (WBRS). A WBRS is basically a tiered pricing system, based on marginal cost pricing that allows the water utility to tailor the rate structure essentially to each household served on the one hand and to secure the recovery of the fixed operational costs of the water utility. WBRS have our purposes: (1) conservation of scarce water resources, (2) financial stability of the water utilitis even during periods with very small water consumption, (3) equity and satisfaction of customers, and (4) funding of conservation and evnvironmental programs without raising taxes on customers.

Introduction

Being in a semi-arid climate, California has faces frequent and prolonged droughts. In a typical policy intervention to facing less water to allocate, state agencies and water utilities responded (in the urban sector) by either cutting water allocations to users or by dramatically increasing water tariffs, or both. The prolonged drought of 1986-1991 has resulted in many cases where water utilities went bankrupt, due to the fact that the conservation impact of their water pricing decreased dramatically the demand for water and the stream of revenue to cover their fixed costs. This has led to the introduction of the WBRS in Southern California, but with the improved water situation the pace of implementation was not impressive.

Drought returned to California in 2007, and lasted until 2011. Water use was restricted throughout the State. Local retail agencies established water moratoriums, particularly for irrigation and agricultural water. At the same time agencies experienced significant revenue shortfalls. The same scenario that prompted the 1st water budget rate structure in 1991 was again at play for agencies in California and throughout the US, where drought was affecting both arid and typically wet regions.

Starting 2008, with the slowdown in economic activity in the state of California, water pricing rates had to be adjusted, revenues of water utilities declined, and customers that saved water have faced increased rates again and again.

The impact of the coupled effect of the increased tiered pricing and the recent economic slowdown in Southern California on the demand for water by households culminated in two important phenomena:

1. Complaints on the part of customers about fairness of existing tier rates that do not distinguish between household characteristics, and

2. Sever concerns on the part of the water utilities regarding reduction in revenues that jeopardize the ability of the utility to cover not only its fixed cost but also part of its variable costs.

The WBRS has emerged as a practice that allows water utilities achieve several objectives, mainly obtain high level of conservation without jeopardizing the financial and political stability of the water utility.

Legislative setting and economic background

This EPI is supported by various state legislations, and follows various bills since the passing of (Assembly Bill) AB 325 of 1990. In 2004, AB 2717 passed, which requested the California Urban Water Conservation Council (CUWCC) to evaluate and recommend proposals for improving the efficiency of water use in new and existing urban irrigated landscapes in California. Based on this charge, the Task Force adopted a comprehensive set of 43 recommendations, essentially making changes to the AB 325 of 1990 and updating the Model Local Water Efficient Landscape Ordinance. The recommendation of the bill charges (the State Department of Water Resources) DWR in updating the Model Efficient Landscape Ordinance and to upgrade (California Irrigation Management Information System) CIMIS.
The Water Conservation in Landscaping Act of 2006 (AB 1881) enacted many, but not all of the recommendations reported to the Governor and Legislature in December 2005 by the CUWCC Landscape Task Force. AB 1881 requires DWR, not later than January 1, 2009, by regulation, to update the model ordinance in accordance with specified requirements, reflecting the provisions of AB 2717. AB 1881 requires local agencies, not later than January 1, 2010, to adopt the updated Model Ordinance or equivalent or it will be automatically adopted by statute. Senate Bill (SB) 7 (approved on 12/2009) requires the state of California to achieve a 20% reduction in urban per capita water use by December 31, 2020.

This comprehensive legislative setting provide water utilities with the necessary legal support for the introduction of the Water Budget Rate Structure, by allowing them to implement measures that would lead to conservation while keeping their financial stability and customer satisfaction.

Brief description of results and impacts of the proposed EPI

WBRS has been practiced in more than a dozen water utilities in Southern California since 1991. Irvine Ranch Water District (IRWD) pioneered the WBRS since 1991. Eastern Municipal Water District (EMWD) implemented WBRS in late 2008, and Western Municipal Water District (WMWD) implemented WBRS only in October 2011. Each of these utilities started from a different situation, existing tiered pricing system, composition of customer groups, and water scarcity. All 3 utilities reported of impressive successes, including the one month experience of WMWD. A brief account of the results includes:

For IRWD: (1) 61% reduction in landscape irrigation water use (dedicated irrigation meters); (2) 25% residential water use reduction; (3) Stable fixed revenue recovery; (4) Reduced water runoff (water quality improvement) (MWDOC-IRWD 2004); (5) Fully funded conservation programs (paid only by water wasters); (6) 85% customer satisfaction (independent customer surveys); (7) re-election of all water board members since 1991, indicating management stability.

For EMWD: (1) water use reductions of 13% (over drought use); (2) revenue increase of 6%; (3) accumulation of cpital for funding for conservation programs.

For WMWD there is no sufficient experience for evluation of results except for results that can be derived from the implementation process that went relatively smooth and trouble-free. Customers had a 98% approval rate of the WBRS prior to its implementation and following a process of discussion as required by the law in Califronia.

Conclusions and lessons learnt

The main conclusion from the long-term experience and the short-term experience with WBRS is that the better the transparency of the rules by which the WBRS will be operated, and the education of the customers and the infrastructure and institutions needed for this EPI the more successful is its implementation in terms of acceptance, and effectiveness. Another conclusion is that the level of success is also a function of the level of detailed information the utility can obtain about the environmental factors in various parts of the service area. In particular, the ability to move from 3 to 50 and 200 climatic zones in the case of IRWD, EMWD and WMWD, respectively, increased the fine tuning of the WBRS and its performance. Finally, having the wholesale agencies in California adopt a water budget methodology to set standards for retail agencies and pricing triggers for excessive water purchases would improve the overall efficiency of the water system in the state of California.

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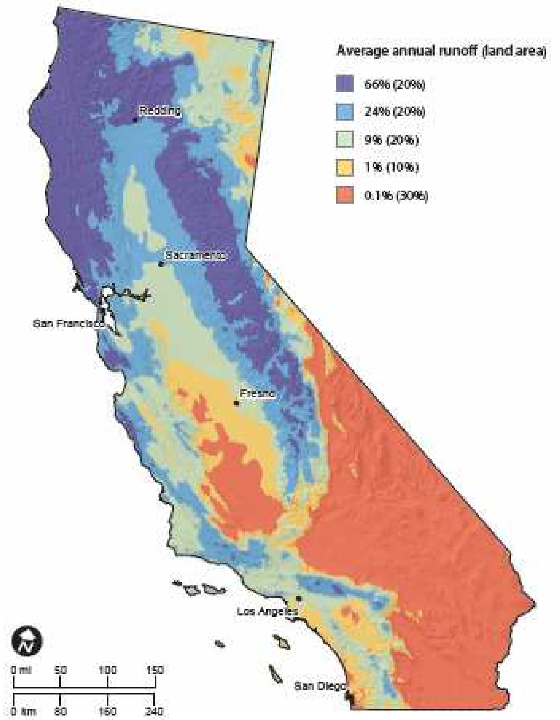
1 EPI Background

Like many other countries/states, most of California's precipitation fall and stored in its northern part (Figure 1) while most of the population and the economic activity concentrate in the south. To close this gap the state of California and the federal government developed sophisticated water delivery systems that move water across the state, from north to south. However, population growth rates in Southern California, with the relatively high rate of water scarcity necessitate some demand management efforts.

Figure 1: Precipitation in California



Source: Hanak et al. 2011.

In an effort to cope with water scarcity, California introduced various mechanisms of Pricing of water as a mechanism to induce water conservation has been long a challenge to water utilities and regulatory agencies in the urban sector (Hewitt, 2000; Hall, 2000), especially in the Western US where water supply is subject to major variation due to prolonged droughts and the semi-arid climate in that region. Traditional volumetric water pricing methods such as the uniform volumetric rate, the increasing block rate, and the decreasing block rate tariffs have had difficulties in addressing efficiency (conservation), financial stability of the water utility agency, and fairness/equity issues accross customer groups. These issues became the trigger for the dissatisfaction from the existing marginal cost rate structures in Tucson Arizona and Los Angeles, following the 1976-1977 and the 1986-1991 droughts they faced, respectively. Having one rate structure that has to fit all customers may not allow the water utility to reach highest possible efficiency without jeopardizing several of the fundamental conditions for stable social optimum. They include financial (revenue) stability for the water utility, reasonable cost of service,satisfaction and fairness in charges of the various types of households served by the utility (Maria-Saleth and Dinar, 2001). Indeed volumetric pricing methods have achieved a great deal of increased efficiency and conservation, but because they were designed based on an 'average household', their ability to achieve highest efficiency and revenue stability under extreme water supply conditions are questionable. Under prolonged drought conditions in California, water utiliteis faced continues water cuts that, given the 'traditional' marginal cost pricing instrumernts they used, reduced water allocations could be met only by increased rates across the board. Higher rates and tiered rates have produced some efficiency, albeit inequitably across customers, and financial instability to the water utilities. What agencies missed in the rate design is the revenue stability and equity part of the formula. The "raising rates" were the only tool they had to drive conservation. This narrow view does create significant political/social conflict for the simpel reason: customers who use water efficiently see their rates go up as the penalty for using water efficiently. Therefore, it is not surprising that what is known as a Water Budget Rate Structure (WBRS) has been adopted and attracting water utilities in regions facing high water scarcity such as Western US. However, the fundamentals of WBRS have the ability to assist any agency in any type of climate to price water accurately, recover costs accurately and to incentivize water use efficiency. The locations of the various water utilities in Southern Califronia that have been involved with the WBRS and are part of the analysis in this paper are depicted in Figure 2.

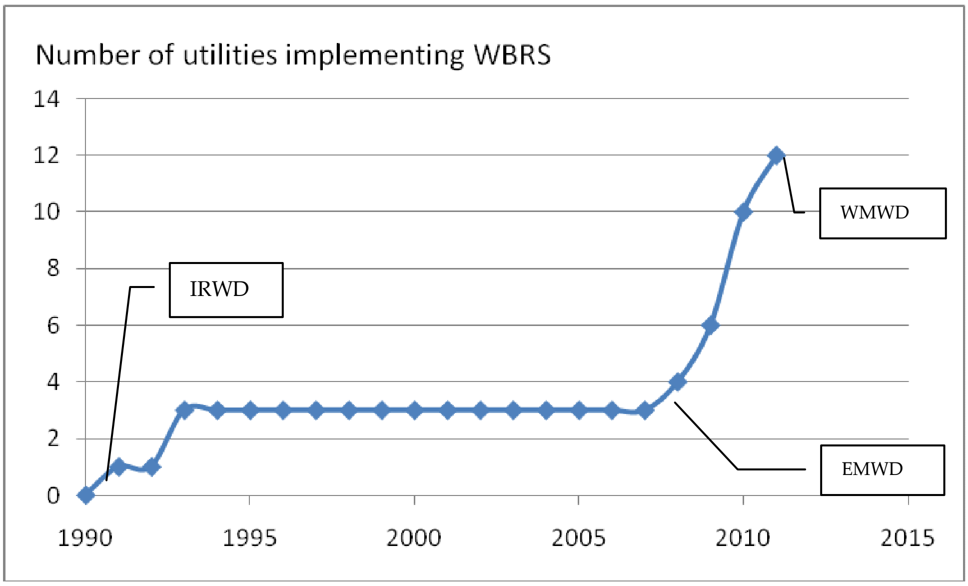
Figure 2: Three Southern California water utilities that implemented the WBRS.

Source: http://www.mwdh2o.com/mwdh2o/pages/memberag/member03.html

The WBRS,[1] which will be explained later in details, allows the water utility to tailor the rate structure essentially to each household served. This flexibility could be enhanced, as we will see below, by use of the advancement in the information technology field (such as remote sensing, finer Evapotranspiration—ET—estimates, Geographic Information Systems, Automated/remote Meter Reading, etc...), although the main technology needed is an adequate billing system software that allows customer-specific adjutments.

In the past quarter of the century, there has been an increase in the number of water utilities in Western US (Figure 3; Table 1), and in particular in Southern California that implement WRBS. This case study will focus on three water utilities in Southern California that have been implementing WBRS between early 1990s and late 2010s with various levels of sophistication. While the nimber of implementing aganecies was stable between 1990 and 2007, WBRS atracted water utilities in Southern California, starting 2008 as a result of a c ombination of economic slow down and prolonged drought situation, both of which lead to reduction in demand for water and direct inpact on the revenue stability of the water utilities.

Figure 3: Diffusion of WBRS in California between 1990 and 2011.



[1]"Water budget-based water rates—also known as individualized, goal-based, and customer specific rates—are block rates where the block is defined by using one or more customer characteristics. Water budget-based rate structures can be thought of as an increasing block rate structure where the block definition is different for each customer, based on an efficient level of water use for that customer" (Mayer 2009:4).

Table 1: Water utilities in Southern Califronia that adopted WBRS and years of adoption

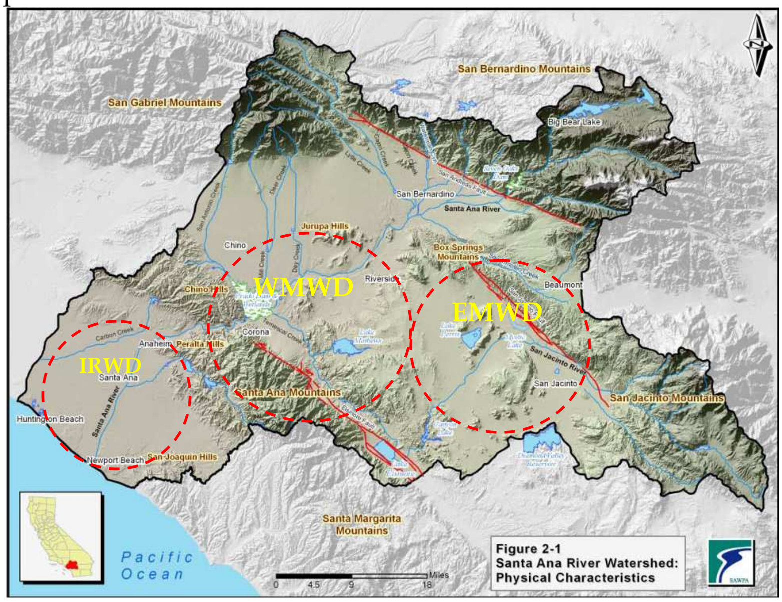
Utility	Year of adoption
Irvine Ranch Water District	1991
San Juan Capistrano Water District	1993
Otay Water District	1993
Eastern Municipal Water District	2008
Palmdale WD Water District	2009
Coachella Valley Water District	2009
Elsinore Valley Water District	2010
City of Corona	2010
Rancho California Water District	2010
El Toro Water District	2010
Moulton Niguel Water District	2011
Western Municipal Water District	2011

Source: Ash (2011)

2 Characterisation of the case study area (or relevant river basin district)

The three water utilities that comprise the case study are located in the Santa Ana river basin (Figure 4).

Figure 4: Map of the Santa Ana Watershed



Source: SAWPA 2010. Red circles do not represent service area boundaries.

The Santa Ana River Watershed drains a 2,650 square-mile area. The watershed is home to over 6 million people and includes the major population centers of parts of Orange, Riverside, and San Bernardino Counties, as well as a sliver of Los Angeles County. The Santa Ana River flows over 100 miles and drains the largest coastal stream system in southern California. It discharges into the Pacific Ocean at the City of Huntington Beach. The total length of the Santa Ana River and its major tributaries is about 700 miles (SAWPA 2010).

The Irvine Ranch Water District (IWRD) is an independent special district serving Central Orange County, California. It provides high-quality drinking water, reliable wastewater collection and treatment, ground-breaking recycled water programs, and environmentally sound urban runoff treatment to more than 330,000 residents. IRWD encompasses approximately 181 square miles extending from the Pacific Coast to the foothills and serves the City of Irvine and portions of Costa Mesa, Lake Forest, Newport Beach, Orange, Tustin and unincorporated areas of Orange County. Approximately 65% of the drinking water supply comes from local groundwater sources. The remaining 35% of IRWD's drinking water comes from the Colorado River (Colorado River through the Colorado River Aqueduct) and the State Water Project (the Sacramento-San Joaquin Delta in Northern California) and is imported by the Metropolitan Water District of Southern California (MWD) (IRWD Water Facts, 2011)

Eastern Municipal Water District (EMWD) services an area of 555 square miles and population of about 700,000 people. The major water sources are imported water from the Colorado River and the state water project (66%), local groundwater and desalinization (16%), and recycled wastewater (18%) (EMWD, 2011).

Western Municipal Water District (WMWD) serves a region of 527 square-miles with a population of about 850,000. The water sources are from the Colorado River (about 20%, purchasing from MWD), the state water project and groundwater. This district operates and maintains domestic and industrial wastewater collection, treatment, and conveyance systems. Annual water deliveries are 125,000 acre-feet (1.05 billion cubic meters). About two-thirds of the water that Western sells is treated; the remaining is untreated or raw water. About 25% of the water sales are for agricultural uses, and 75% is for domestic purposes (WMWD, 2011).

3 Assessment Criteria

WBRS is a tiered pricing scheme, but it differs from the traditional increased tier pricing schemes in that it is designed to provide revenue security to the water utility and at the same time guarantee fairness to the customers.

Fixed costs of service are handled, mainly by political compromise. Of the amount calculated as fixed cost of service, utilities distribute certain percentage as fixed (irrespective of water use by the customer) and the remaining percentage as variable, assigned to the amount of water used. Utilities are aware of the tradeoff between risk of low cost recovery of the fixed share and customer dissatisfaction from higher rates. Common practice among water utilities is to set the ratio off fixed cost distribution between the fixed and the variable portion of the bill to 20-30" and 80-70% respectively.

The WBRS is comprised of fixed costs and variable cost components. The fixed cost part is kept at a both a reasonable level for the customers and the water utility. The variable costs are comprised of several increasing tiers (between 4-6), depending on the water utility. The first and second tiers represent reasonable use of water by about 75% of the customers. The first tier in each WBRS refers to indoor water use and the second tier refers to outdoor water use. Both of these two tiers are anchored to legal and scientific parameters as follows:

$$IDU = R \cdot IS \cdot D$$

$$ODU = (ET) \cdot (LF) \cdot (SF) \cdot (DF)$$

$$MWA = [IDU + ODU] \cdot DM$$

where IDU is indoor water use by the residency; R is the number of residents in the household; IS is the indoor water use standard per capita (set at 55 gallons per capita per day (gpd/d)[2] although some water utilities use the value of 60 too); D is the number of days in the billing cycle; ODU is outdoor water use; ET is the evapotranspiration value in inches per acre[3] per day of a representative fescue grass; LF is the landscape factor set at 0.80; SF is the lot size (acres); DF is a drought factor (fraction), representing the water reduction the retail agency faces;[4] MWA is monthly water allotment in ccf;[5] and DM is days per month.

Customers that exceed the first two tiers are considered not-efficient and face a significantly higher prices per unit of water consumed, compared to the second tier. Many water utilities compute the prices of the tiers following the second tier, by using the next alternative for water (the opportunity cost approach), such as imported water or water that are associated with much higher cost of provision. The WBRS is applied to the service area of the utility, using normative parameters. Customers are given then the option of requesting to adjust the tiers (Variance) to their own parameters. A Simple scheme of the WBRS with two customers, A and B (where customer B requested to adjust tier 1 to her specific conditions is provided in Figure 3. Customers can request variance in tier 1 and/or 2 only.

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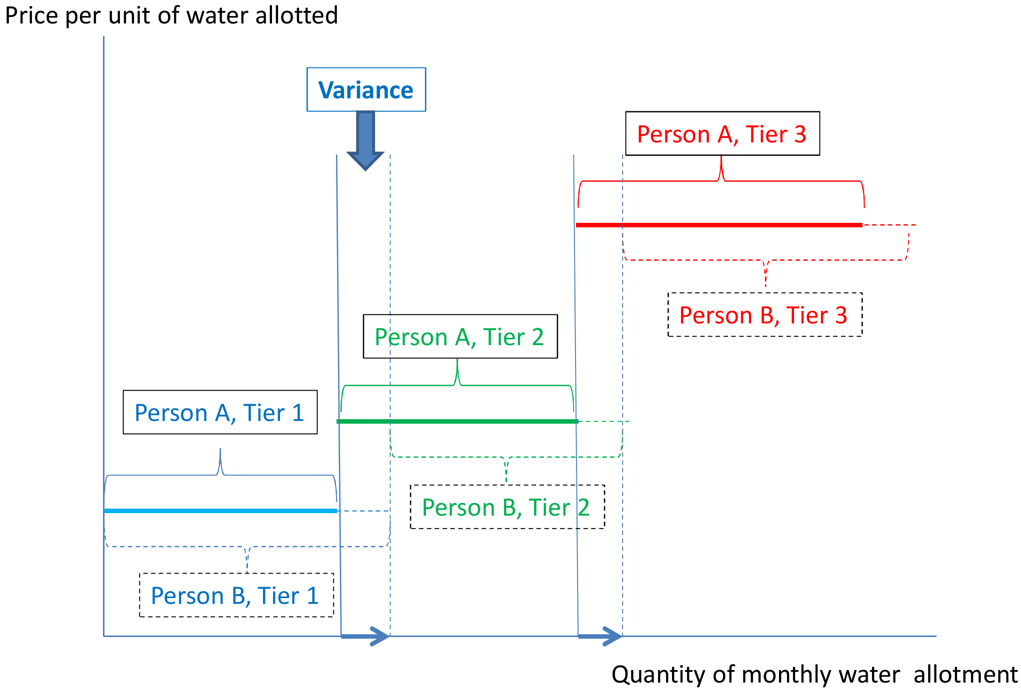
[2] 1 gallon ≅ 4 litters.

[3] 1 acre ≅ 0.4 hectare.

[4] Some water utilities use the DF to adjust both the ODU and the IDU.

[5] 1 ccf ≅ 100 cubic feet or 748 gallons

Figure 3: Scheme of the Water Budget Rate Structure.



The three water utilities comprising the case study use an allocation-based conservation rate structure, described in general terms above, which offers property specific water budgets and tiered pricing to provide each of its customers with economic incentives for efficient water use. In addition to providing incentives for saving to the customers, the WBRS provides incentives to the water utilities to set the fixed costs and the tier levels in such a way to increase satisfaction of the customers and thus, the long-term stability of the water utility budget. Another pillar of the WBRS achievement is that the revenue collected from higher tier water use is reinvested in promoting long-term improvement programs in water use efficiency and support the water utility urban runoff programs that reduce pollution of aquifers and wetlands.

The three water utilities established customized and equitable water for each customer by allowing 'variance'—an increase in the normalized amounts of indoor and outdoor allocations—such as: updated number of people in the household; people with special needs, irrigated area, livestock on premise, or business type. The rate structure as of July 2011 is presented in Table 1.

Table 1: Residential rates ($/ccf) in IRWD (effective July 1, 2011), EMWD and WMWD (effective October 1, 2011).

IRWD[6]			EMWD[7]			WMWD		
Tier	Rate ($/ccf)	% of allocation	Tier	Rate ($/ccf)	% of allocation	Tier	Rate ($/ccf)	% of allocation
Low volume	0.91	0-40	Indoor	1.483	0-50	Efficient indoor	1.77	
Base rate	1.22	41-100	Outdoor	2.714	50-100	Efficient outdoor	1.87	
Inefficient	2.50	101-150	Excessive	4.864	100-150	Inefficient	2.41[a]	100-125
Excessive	4.32	151-200	Wasteful	8.898	150+	Excessive	3.78[b]	125-150
Wasteful	9.48	200+	N/A	N/A	N/A	Unsustainable	4.67[c]	150+

Sources: IRWD 2011; EMWD, 2011; WMWD, 2011.
Note: First two tiers of each water utility constitute the total allocation.
[a]Including $0.30 to fund efficiency and environmentally-related programs.
[b]Including $0.60 to fund efficiency and environmentally-related programs.
[c]Including $1.49 to fund efficiency and environmentally-related programs.

3.1 Environmental outcomes

While the WBRS's declared motivation is for the water utility financial stability, for water conservation, and for customer satisfaction, environmental benefits are an integral outcome of WBRS and can be estimated from the performance of the water utility before and after the implementation of the WBRS.

At this point several environmental outcomes are identifiable, which are quantifiable and will be estimated and presented at the next version of the report:

1. Reduction of pollution of water bodies (aquifers, wetlands) from pesticides, nitrates in outdoor irrigation runoff;

[6] The original Rate structure set in 1991 were more restrictive, as follows: (1) Low volume 0-40% of allocation at ¾ of the base rate; Conservation 41-100 %of allocation at base rate; Penalty 101-110% of allocation at twice the base rate; Excessive 111-120% of allocation at 4 times the base rate; and Abusive +120% of allocation at 8 times the base rate. This rate has evolved over time and went through several modifications.

[7] EMWD initiated a WBRS in 1992 for new customers only and then adopted a tiered rate structure for all its service area in 1993. Due to economic recession and drought EMWD increased tariffs by 34% in the summer of 1993 and Faced angry protests from customers that led to retrieval from the tiered pricing to increased fixed rates (Pekelney and Chessnut, 1977:2-1—2-14).

2. Reduction in import of lower quality (higher salinity content) water from the Colorado River resulting in (a) need for less energy for water treatment and (b) less contamination of aquifers and soils from use of water with highr levels of salinity;
3. Reduction of negative environmental impact in the source (Colorado River Basin) from transporting water out of basin;
4. Establishment of stable urban carbon sequestration patterns by allowing sustainably growing trees in a reasonable cost of water;

3.2 Economic Assessment Criteria

IRWD, facing an extended drought (1987-1993), reduction in regional allocations set by MWD, wholesale price increases, and revenue loss from lower water sales, set out to re-design water rates that would meet all of the needs of the agency. IRWD requested the Univ. of California to place a water conservation advisor (Tom Ash) at the district in January 1991 to assist with water rates and conservation programs, now known as "water budget rate structure".

With internal agency staff including finance, customer service and public affairs, the design of a new conservation rate structure was delineated to address the following fundamental questions (1) How can a rate structure recover costs accurately? (2) How can a rate structure identify water wasters? (3) How can a rate structure send a clear economic message to customers on their water use? And (4) Can a rate structure reduce water use and avoid raising rates if less water is sold?

IRWD arrived at a water budget tiered rate structure that includes 1) recovery of 75% of fixed costs on a fixed "service" charge (a change from 25% of fixed cost recovery in its existing rate structure); (2) individualized customer allocations (based on per resident gallons per day (gpd); (3) local evapotranspiration and size of landscapes); (4) Daily downloads of 3 microclimate evapotranspiration zone data into the billing system; (5) Low variable base price; (6) Steep inclining tiered prices; and (7) Variance system to adapt individual customer allocation variables as necessary.

IRWD implemented the new rate structure in June of 1991. The drought and regional restrictions lasted another 2 years until March 1993 when heavy rains ended the 6-year drought.

The impact of the IRWD water budget rate structure was documented by the agency and reviewed in an independent study by MWD, the regional wholesale agency (Pekelney and Chestnut, 1997). Overall the 1st water budget rate structure accomplished the following (1) 61% reduction in landscape irrigation water use (dedicated irrigation meters); (2) 25% residential water use reduction; (3) Stable fixed revenue recovery; (4) Reduced water runoff (water quality improvement) (MWDOC-IRWD 2004); (5) Fully funded conservation programs (paid only by water wasters); (6) 85% customer satisfaction (independent customer surveys); (7) re-election of all water board members since 1991. The rate structure has operated for 20 years, during drought and wet years, and has continued to recover appropriate revenues and keep efficiency at a high level.

The EMWD service area is located in the hot inland of southern California, where customers have a wide range of lot sizes, pools, horses and residents per household. In 2008 the EMWD was facing a significant drought, State and regional water restrictions and declining revenues as customers cut water use due to the declining economy and drought. The board of directors agreed with the goals of classic water budget rate design especially in terms of customer equity, and directed staff to create a WBRS implementation plan. In 2009 EMWD implemented the WBRS.

Features of the EMWD water budget rate structure include (1) individualized allocations for all residential, commercial and irrigation accounts; (2) daily ET for 50 microclimates in the service area; (3) indoor and outdoor allocations that is subject to State legislation; and (4) variance program to insure accurate allocations for individual customer accounts. The impacts to date include (1) water use reductions of 13% (over drought use); (2) revenue increase of 6%; (3) accumulation of cpital for funding for conservation programs.

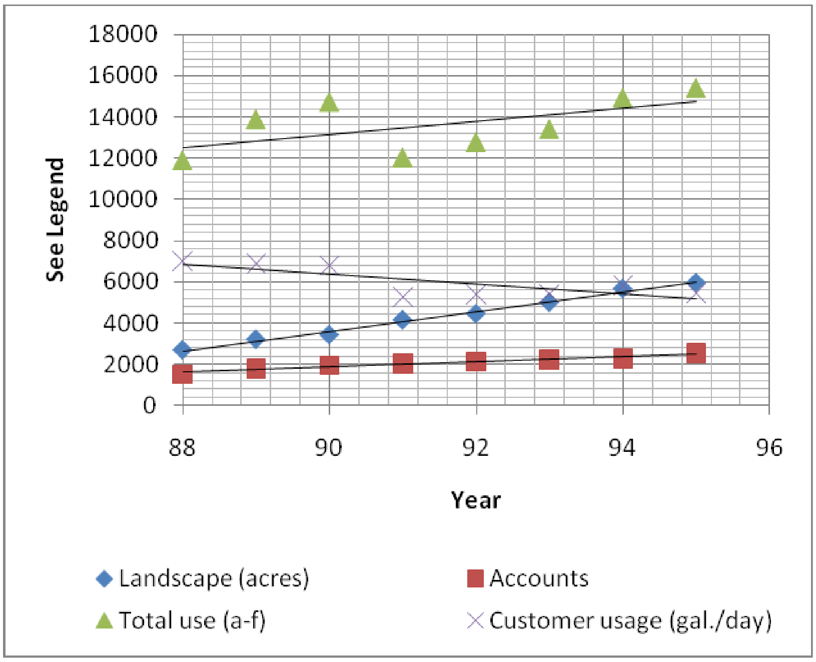
In 2008 the WMWD was also facing drought restrictions and declining revenues with their traditional flat fixed cost rate structure. The agency decided to adopt the WBRS. However, their billing system was antiquated and needed a full software and hardware upgrade. The agency carefully re-built its billing system, navigated through elections and were mindful of the impact of recession and water rates on customers in the service area. The features of the WMWD water budget rate structure include (1) lower base rate for indoor water need; (2) individual allocations for residential, commercial and irrigation accounts; (3) drought factor built into the allocation equation; (4) variance program for individual customer allocation adjustments; (5) fully funded conservation programs paid only by water wasters (tiers 3-5); (6) increased emphasis on customer services; (7) daily ET for 200 microclimates in the service area.

While WMWD doesn't yet have sufficient information on performance, it still represent the most advanced WBRS design and implementation and may serve as model of how an agency can carefully study, consider, coordinate an implementation plan with a comprehensive public outreach campaign to roll-out a rate structure reform. Following an extensive educational campaign, WMWD was able to proceed with confidence to complete work on their billing system, rate design and public outreach campaign. With an improved customers outreach, lower water rates, identification of efficient and wasteful users, and individualized allocations, WMWD was able to receive 98% customer approval of the new rate structure by customers (via Prop 218, the California law that requires any change of taxes or rates to be voted-on by local affected customers).

3.2.1 Assessment of water savings

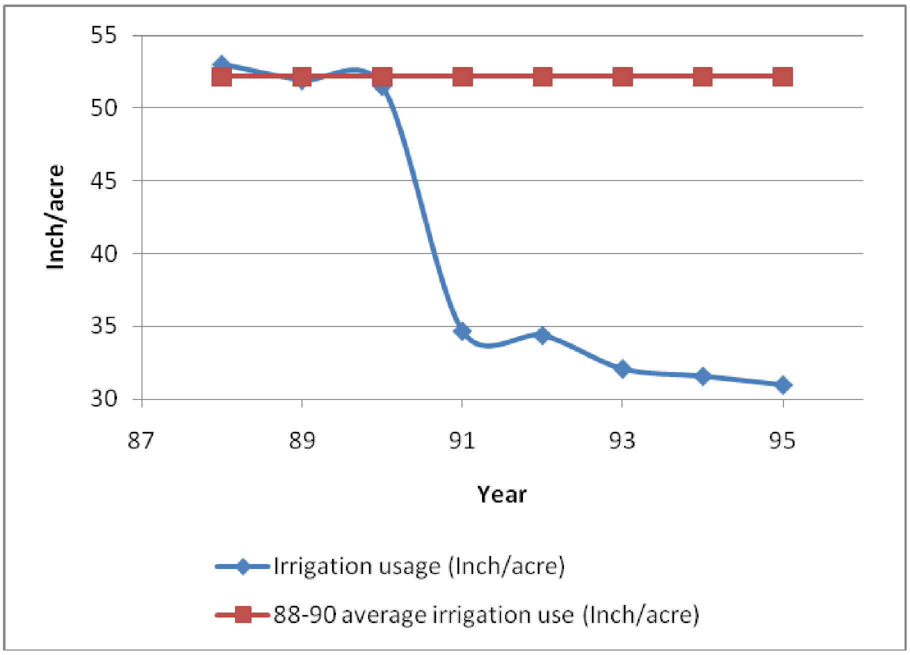
Landscape irrigation accounts for at least 50% of urban water use in Southern Califronia (Hanak et al. 2011:97, Fig. 2.12). An analysis of water usage in outdoor landscape irrigation by urban customers in IRWD between 1988 and 1995 suggests savings from 34 to 41% between pre WBRS implementation (1988-1990) and post WRBS implementation (1991-1995). The results are summarized in Figures 5 and 6 below.

Figure 5: Physical parameters of water us in IEWD during 1988-1995.



Note: Based on data in Pekelney and Chessnut (1997:Table 4.3)

Figure 6: Actual reduction in landcape water use by IRWD customers between 1988-1995.



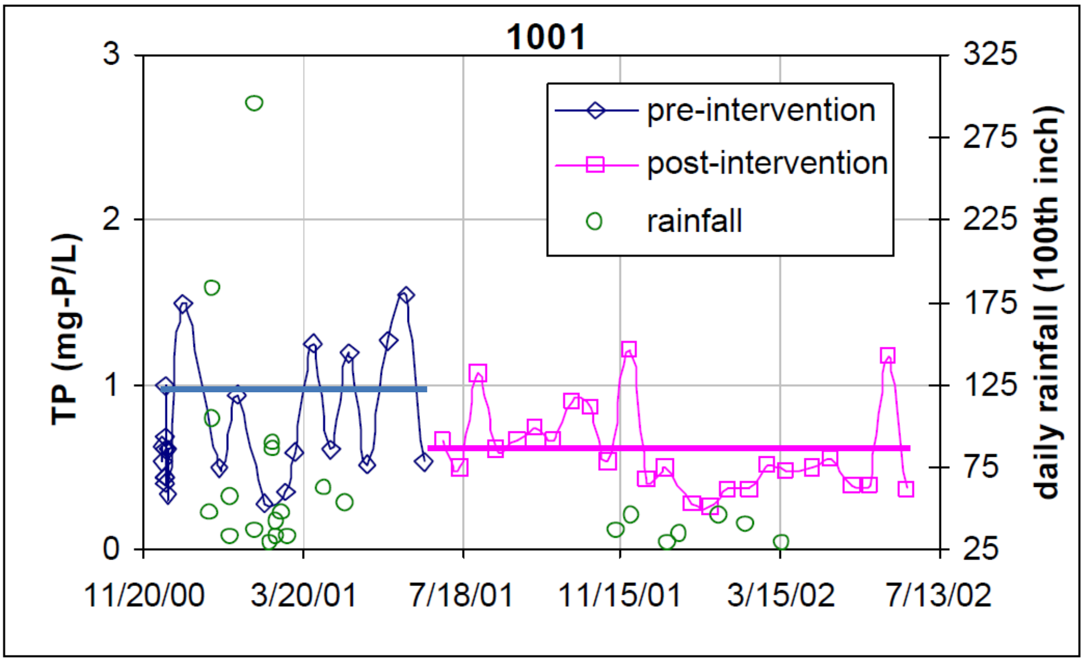
Note: Based on data in Pekelney and Chessnut (1997:Table 4.3)

3.2.2 Assessment of water savings

With the significant percentage of residential water demand used for outdoor purposes excess landscape irrigation results also in increased runoff that is the transport mechanism of pollutants that enter natural waterways and, ultimately, the Pacific Ocean.

A study focusing on estimation of runoff from residential plots and the level of pollutants transported was conducted between 2000 and 2002 in a small residential area of IRWD (MWDOC-IRWD 2004) comparing runoff and concentration of pollutants in the runoff during the dry season of the year. The study collected data on the water quality constituents present in urban runoff. The water quality component related to total phosphorous in one residential plot is presented in Figure 7.

Figure 7: Time-series of total Phosphorus from plot 1001 of the Runoff Study at San Diego Creak, IRWD.



Source: MWDOC-IRWD (2004: Fig. 5.3). Straight lines are indicatory means.

However, in almost all cases, the data showed no changes in the concentration of these constituents in the runoff.

3.3 Distributional Effects and Social Equity

Although the objectives of WBRS are to conserve water while recovering the cost of service, there is still a very significant component of improved distributional effects and social justice. The suggested procedures for distributional effects and social justice can be easily estimated for each water utility (the quantitative estimates would be provided in the final draft).

The WBRS provides for what is called 'variance', which is a request for increase in water budget either in tiers 1 or 2 for each customer. Since the variance in tier 2 is for mainly lot sizes and uses for animals, it will not be considered in the analysis of distributional effects and social equity. Instead, only variance requests for tier 1, submitted and approved by the water utility represent social equity.

We will use the increase in indoor water allocation (that is associated with the lowest price per unit of water) following a variance request process as the indicator for the distributional effects and social equity derived from the WBRS.

Let Q_j be the quantity of water in tier 1 allocated to household j in the original implementation of the WBRS. Let Q_j^* be the quantity of water allocated to household after the variance process ($Q_j^* > Q_j$). Let $p^{WBRS\ tier\ 1}$ be the price of the first tier facing the household in the WBRS. One indicator of the household benefits after the variance process compared with the tiered water pricing $p^{Pre-WBRS\ tier\ 1}$, $p^{Pre-WBRS\ tier\ 2}$ that existed in the pre-WBRS is

$$[q_{j1} \cdot p^{Pre-WBRS\ tier\ 1} + q_{j2} \cdot p^{Pre-WBRS\ tier\ 1}] - Q_j^* \cdot p^{WBRS\ tier\ 1}$$

such that $q_{j1} + q_{j2} = Q_j^*$.

A second indicator of the distributional effects of the WBRS after the variance process was completed compared with the original allocation for tier 1 is

$$(Q_j^* - Q_j) \cdot p^{WBRS\ tier\ 1}$$

With information about the household accounts in each of the water districts and the variance levels requested and approved in the service area of the water utility for J households, it is possible to estimate the total welfare transfers in each water utility and the distribution of such welfare.

3.4 Institutions

While the state provided legal guidance for the design and implementation of the WBRS, there are also local institutions following the individual water utility bylaws. Both will be discussed below.

WBRS is supported by various state legislations, and follows various bills since 1990s (http://www.water.ca.gov/wateruseefficiency/landscapeordinance/updatedOrd_history.cfm#summary). In 2004, (Assembly Bill) AB 2717 was passed, which requested the California Urban Water Conservation Council (CUWCC) to convene a stakeholder task force, composed of public and private agencies, in order to evaluate and recommend proposals for improving the efficiency of water use in new and existing urban irrigated landscapes in California. Based on this charge, the Task Force adopted a comprehensive set of 43 recommendations, essentially making changes to the AB 325 of 1990 and updating the Model Local Water Efficient Landscape Ordinance. The recommendation of the bill charges (the State Department of Water Resources) DWR in updating the Model Efficient Landscape Ordinance and to upgrade (California Irrigation Management Information System) CIMIS.

The Water Conservation in Landscaping Act of 2006 (AB 1881) enacts many, but not all of the recommendations reported to the Governor and Legislature in December 2005 by the CUWCC Landscape Task Force (Task Force). AB 1881 requires DWR, not later than January 1, 2009, by regulation, to update the model ordinance in accordance with specified requirements, reflecting the provisions of AB 2717. AB 1881 requires local agencies, not later than January 1, 2010, to adopt the updated model ordinance or equivalent or it will be automatically adopted by statute. Also, the bill requires the Energy Commission, in consultation with DWR, to adopt, by regulation, performance standards and labelling requirements for landscape irrigation equipment, including irrigation controllers, moisture sensors, emission devices, and valves to reduce the wasteful, uneconomic, inefficient, or unnecessary consumption of energy or water. Senate Bill (SB) 7 (approved on 12/2009) requires the state to achieve a 20% reduction in urban per capita water use in California by December 31, 2020.

3.5 Policy Implementability

The following outlines the ideal steps for designing a Water Budget Rate Structure, based on experiences from water utilities who have implemented WBRS (Ash 2011).

1. Determine the agency costs for service, both fixed and variable
    - determine revenue requirements for the agency, parameters for a revenue neutral cost recovery, etc.
2. Accurately identify customer issues and expectations
    - Conduct customer surveys to identify hot spots
3. Determine the allocations and variables affecting demand for each customer group
    - Residential Allocation
    - Irrigation/Landscape Allocation
    - Multi-family Allocation
    - Agriculture Allocation
    - Commercial Allocation
4. Accumulate customer data
    - Residents per household
    - Square footage of outdoor irrigated area
5. Identify accurate ET data for daily downloading into billing system
    - Based on service area microclimates, availability of ET weather stations, etc...
6. Test (simulate) customer use in the WBRS
    - How many customers would meet allocations at current use patterns
7. Test financial requirements in the WBRS
    - Model different fixed/variable recovery scenarios
8. Finalize policies on rates
    - Allocations
    - Tiers (number and width)

- Prices per tier
  - Amounts to go for conservation and environmental programs (see item 12 below)
  - Adjustments and credits
9. Identify billing system requirements/upgrades
10. Identify implementation timeline
    - Billing system upgrade completed
    - Board election schedule
    - Prop 218 process (California only)
    - Outreach campaign
11. Staffing needs (if any)
12. Efficiency programs upgrade
    - Programs to assist customers to reduce water waste
      - Residential programs
      - Landscape efficiency programs
      - Ag efficiency programs
      - Commercial efficiency programs
13. Website upgrade
    - Customer education of WBRS
    - Water budget estimator tool
    - Efficiency programs, workshops, etc.
14. Internal staff training
    - Customer service, conservation, board, general employee
15. Internal tracking tools
16. Implementation
17. Continuing customer education
18. Excess revenue/conservation fund establishment
19. Board and public education/reporting

3.6 Transaction Costs

The main transaction costs associated with the implementation of WBRS are associated with the Proposition 218, which requires meeting the cost of service standards, including a process of hearing and approval of changes in water rates by customers. Water utilities are therefore obliged to submit themselves to a serious and long process of customer education. Following the educational process interacts with public hearing, where customers can make their opinions heard. There are several examples where the public opinion of frustrated customers derailed the process of tariff change (such as the case of EMWD in 1992 (Pekelney and Chessnut, 1997).

3.7 Uncertainty

The current rate structures are very uncertain in terms of revenue generation, thus on the ability of the water utilities to sustain their services. That is due to the design of a collection of a small portion of the fixed costs in the structure and linking the remaining share of the fixed cost recovery to water sales, while at the same time working to get customers to use less water. The reason for having a small share of the fixed cost recovered independently of water use is certainly political. Therefore, with improved saving, namely, with reduction in water sales, the part of the fixed cost that is linked to water sale will be jeopardized and may lead to change in the rates.

A safer water budget rate structure suggests that the majority of fixed costs are recovered independent of water sales. When that is done the agency is free to pursue conservation at the rate they need, and eliminates the bad political and socially unjust action of raising rates if not enough water is sold. The agencies with WBRS experience more stable revenue recovery (reduced uncertainty).

4 Conclusions

Agencies with water budget rates have succeeded in stabilizing revenues, reducing risk of revenue loss when customers use less water, increasing water efficiency, improving customer services and even reducing urban runoff. Many agencies are unaware or apprehensive about making a rate structure change, particularly to a more sophisticated structure that would require technical upgrades, public education and staff training. However, current rate structure designs are the cause for agencies losing necessary revenues, angering customers who save water or have large families or large properties. Currently agencies have only one method to recover revenue lost if customers use less water. A water budget rate structure can permanently fix the structural problem of current rate structures, drive more water conservation and appease customers with individualized allocations.

4.1 Lessons learned

Water is delivered in California by wholesale and retail agencies. WBRS are typically used at present by retail agencies as a means to establish efficiency standards for end users. Legislation in California has set efficiency standards and allocations, such as per capita per day indoor use (SB 7-7) and 80% of local ET for outdoor use, as current and reasonable allocations (AB 1881). Wholesale agencies in California also operate under State law in terms of water efficiency goals, however the wholesale rate structures do not incorporate water budget methodology to set standards for retail agencies and pricing triggers for excessive water purchases. With State of California efficiency guidelines now set, it could be useful to align the entire chain so that wholesale agencies and retail agencies apply water budget rates. The benefits to wholesale agencies would be very similar as those for retail agencies, specifically a wholesale agency would:

1. Recover fixed costs separately from water sales
2. Establish agency by agency water budgets (as per SBX7-7 guidelines)
3. Charge increasing tier prices for water used above the agency allocation
4. Align wholesale rate structure with State legislation and retail agency practices for a more consistent public message and education

4.2 Enabling / Disabling Factors

The experiences of the various water utilities (not only those included in the case study) suggest the following aspects as enabling/disabling factors in the implementation of WBRS:

- Appropriate billing system to allow addressing all the aspects of WBRS and provide needed flexibility in the adjustment (variance) process;
- Access to appropriate climate data to allow proper calculations of ET per unit of consumption and prevent using averages;
- Technological advancements to verify claims by households and to record usage and wastage in order to help the utility address disputes by customers.

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6 Data Sources

See Reference

7 Annexes

Annex II: Acknowledgments

This report benefitted from discussions with and input/feedback from Tom Ash (Tom Ash and Associates, t-ash@sbcglobal.net, 949.922.9539).
Tom Ash has over 25 years of experience in the fields of water use efficiency, water rates and public education working with 13 water utilities and cities in and outside California. As a water conservation specialist from the University of California Cooperative Extension, Tom was the University liaison to water agencies in southern California starting in 1987. He built the first water conservation demonstration garden at the beginning of a 6 year drought (1987-1993) at Western Municipal Water District. In 1991 the University placed Tom at the Irvine Ranch Water District to assist in the design and implementation of the first water budget tiered rate structure for water agencies.