Economic Approach to Estimating the Value of Water

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1. Water valuation methods
2. Application to four SW Florida utilities
3. Using estimated water values in decision making
1. Water Valuation Methods
Value of potable water definition

• Maximum willingness-to-pay (WTP) for water of specific:
  • Quantity – per day, per year
  • Reliability – restrictions, water pressure, boil water orders
  • Quality – safe potable water
• Marginal value - for an additional unit of water
• Total value - for all units of water purchased
• For individual, total value is sum of the marginal values in each use
Value of water depends on its use

- **Essential water uses**
  - Water used for drinking, cooking and sanitation
  - Tied to meeting basic human health needs and do not include water waste

- **Discretionary water uses**
  - Water uses for all other purposes such as lawn/landscape irrigation, car washing, and to fill pools and fountains
  - Uses that customer can manage relatively easily based on income, prices, and water shortage conditions
Water value depends on water use

Essential Uses – drinking, cooking, sanitation

Discretionary Uses
Methods to estimate water value

1. Statistical estimation using –
   a) Passively-generated customer data and perhaps data from nearby utilities
   b) Data collected from survey of water customers and other water users

2. Benefits-transfer using results of valuation studies of other utilities
Value influenced by price elasticity of water demand

- Measures extent to which customer will change amount of water purchased in response to a change in real water price, all else equal
- Defined by % change in amount of water purchased in response to a 1% change in water price
- Price elasticity of -0.4 means that a 10% increase in price results in a 4% reduction in amount of water purchased
Water demand is inelastic: 
\[-1 < E_p(water) < 0\]

Elasticity values chosen to represent utility’s customers based on climate, weather and customer characteristics.

Price elasticity of demand estimates for benefits-transfer compiled: 144 residential; 17 commercial; 42 industrial.

### Price elasticity of water demand estimates from literature

<table>
<thead>
<tr>
<th>Customer Sector</th>
<th>Range of Short Run Price Elasticity Values</th>
<th>Average of Midpoint of Water Demand Elasticities Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>-0.10 to -0.70</td>
<td>-0.40 (a)</td>
</tr>
<tr>
<td>Commercial/Government</td>
<td>-0.10 to -0.25</td>
<td>-0.18 (midpoint)</td>
</tr>
</tbody>
</table>

(a) Average of 314 price elasticities of water demand from Dalhuisen et al. (2003)
Observable factors that determine amount of water used

- Water and Sewer Price
- Income / Profit
- Irrigation requirements (weather)
- Household size / no. of employees
- Water using technologies
- Type and amount of production
Q(i,t) = b0 + b1 x P(i,t) + b2 x F2(i,t) + … + bk x Fk(i,t) + e(i,t)

Where:
- Q(i,t) is water use by the ith customer during time t or billing period t;
- b0 is the constant of the estimated equation;
- P(i,t) is the water and sewer price;
- F2(i,t), …, Fk(i,t) are other factors that influence water use;
- b1, b2, … bk are the coefficients estimated by the regression; and,
- e(i,t) is the estimation error.
Water demand equation implies water value

Single Family Household Annual Water Demand Equation
(Price varies and all other factors are constant)

Value of Water = Consumer Surplus + Water (& Sewer) Bill
Water demand equation implies water value

Single Family Household Annual Water Demand Equation
(Price varies and all other factors are constant)

Value of Water = Consumer Surplus + Water (& Sewer) Bill

Only this part of demand curve can be estimated using passive data
2. Application to four SW Florida utilities
Benefit of additional water supply

- Avoidance of water shortages
- Utility and WMD reaction to water shortages
- Reduce discretionary water uses
  - Lawn watering restrictions
  - Other outdoor use restrictions
  - Stop water waste through conservation practices
- In practice, essential uses would be supplied
- Value of additional water supply is preservation of discretionary uses
- Discretionary uses have value to customers
Valuing water using benefits transfer

• Two pieces of information needed to “draw” demand curve:
  • Price elasticity of demand estimate from other water demand studies
  • A point on the demand curve – current price and quantity sold
• Values discretionary water uses only
• \( E_P = \text{Percent change in quantity of water demanded} \)
  \( = \text{Percent change in water and sewer price} \)
• Example: \( E_P = -0.40 \) means that a 10% increase in real price results in a 4% reduction in water sold to customers
### Price Elasticity of Water Demand and Point on the Demand Curve

<table>
<thead>
<tr>
<th>Utility</th>
<th>Price Elasticity</th>
<th>Marginal Water and Sewer Price per TG</th>
<th>Monthly Household Water Use in TG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonita Springs</td>
<td>-0.40</td>
<td>$8.92</td>
<td>15.69</td>
</tr>
<tr>
<td>Collier County</td>
<td>-0.40</td>
<td>$9.88</td>
<td>12.09</td>
</tr>
<tr>
<td>Cape Coral</td>
<td>-0.40</td>
<td>$13.59</td>
<td>7.96</td>
</tr>
<tr>
<td>Lee County</td>
<td>-0.40</td>
<td>$9.94</td>
<td>7.63</td>
</tr>
</tbody>
</table>

Construct water demand equations of four Florida utilities
Bonita Springs Residential Water Values

**Estimated demand equation:**
Quantity = 22 – 0.70 x Price

**Discretionary Water Use per Household:**
Total Value = $183 / month or $2,200 / year or $17 / kgal
Value net of water and sewer bill = $64 / month or $763 / year or $6 / kgal

**Water Quantity per Month (TG)***
*includes waste water rate of $3.70 per TG, does not include fixed changes
Estimated demand equation:
Quantity = 11 – 0.23 x Price

Discretionary Water Use per Household:
Total Value = $66 / month or $792 / year or $20 / kgal
Value net of water and sewer bill = $7 / month or $82 / year or $2 / kgal

Water Price ($ per TG)*

Water Quantity per Month (TG)*

* includes waste water rate of $9.04 per TG, does not include fixed changes

KEY
- Water bill associated with essential water use
- Water bill associated with discretionary water use
- Consumer surplus

Total Value of Discretionary Water Use = (Q, A, B, Q_i)
Collier County Residential Water Values

Estimated demand equation:
Quantity = 17 – 0.49 \times \text{Price}

Discretionary Water Use per Household:
Total Value = $128 / month or $1,500 / year or $17 / kgal
Value net of water and sewer bill = $32 / month or $384 / year or $4 / kgal

* includes waste water rate of $4.34 per TG, does not include fixed changes
Estimated demand equation:

\[ \text{Quantity} = 11 - 0.31 \times \text{Price} \]

Discretionary Water Use per Household:

Total Value = $43 / month or $516 / year or $15 / kgal

Value net of water and sewer bill = $2.25 / month or $27 / year or $0.76 / kgal

Water Quantity per Month (TG)*

* includes waste water rate of $5.86 per TG, does not include fixed changes
## Water Use and Discretionary Water Value of Four Selected Florida Utilities

<table>
<thead>
<tr>
<th>Row No.</th>
<th>Item</th>
<th>Bonita Springs</th>
<th>Collier County</th>
<th>Cape Coral</th>
<th>Lee County</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Average thousand gallons (TG) per household per month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>Total water use</td>
<td>15.68</td>
<td>12.09</td>
<td>7.96</td>
<td>7.63</td>
</tr>
<tr>
<td>(3)</td>
<td>Essential water use</td>
<td>4.73</td>
<td>4.73</td>
<td>4.73</td>
<td>4.73</td>
</tr>
<tr>
<td>(4) = (2) - (3)</td>
<td>Discretionary water use</td>
<td>10.95</td>
<td>7.36</td>
<td>3.23</td>
<td>2.90</td>
</tr>
<tr>
<td>(5)</td>
<td>Discretionary water use - monthly $ values per household</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>Total value</td>
<td>$183</td>
<td>$128</td>
<td>$66</td>
<td>$43</td>
</tr>
<tr>
<td>(7)</td>
<td>Water and sewer bill</td>
<td>$119</td>
<td>$96</td>
<td>$59</td>
<td>$40</td>
</tr>
<tr>
<td>(8) = (6) - (7)</td>
<td>Net water value</td>
<td>$64</td>
<td>$32</td>
<td>$7</td>
<td>$3</td>
</tr>
<tr>
<td>(9)</td>
<td>Value of additional water supply using average discretionary water value $ per 1,000 gallons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10 ) = (6) / (4)</td>
<td>Total value</td>
<td>$17</td>
<td>$17</td>
<td>$20</td>
<td>$15</td>
</tr>
<tr>
<td>(11 ) = (7) / (4)</td>
<td>Water and sewer bill</td>
<td>$11</td>
<td>$13</td>
<td>$18</td>
<td>$14</td>
</tr>
<tr>
<td>(12 ) = (8) / (4)</td>
<td>Net water value – Maximum increase in water supply cost that customers willing to pay</td>
<td>$6</td>
<td>$4</td>
<td>$2</td>
<td>$1</td>
</tr>
</tbody>
</table>
Water use values useful to utility decision making

<table>
<thead>
<tr>
<th>Item</th>
<th>Bonita Springs</th>
<th>Collier County</th>
<th>Cape Coral</th>
<th>Lee County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total value</td>
<td>$17</td>
<td>$17</td>
<td>$20</td>
<td>$15</td>
</tr>
<tr>
<td>Water and sewer bill</td>
<td>$11</td>
<td>$13</td>
<td>$18</td>
<td>$14</td>
</tr>
<tr>
<td>Net water value</td>
<td>$6</td>
<td>$4</td>
<td>$2</td>
<td>$1</td>
</tr>
</tbody>
</table>

**Total value:** Residential customers in Bonita Springs are willing to pay up to $17 per 1,000 gallons of water for discretionary uses.

**Net water value:** Water supply projects that do not increase the cost of water by more than $6 per 1,000 gallons and that continue to supply discretionary uses would be supported by the public.

**Note:** This is discretionary water use ONLY. The value of essential water use is much higher than reported in this table.
3. Using estimated water values in decision making
### Estimated Annual Benefits and Costs of Proposed Four Corners Reservoir, 2017 $

<table>
<thead>
<tr>
<th>Item</th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>Alternative C</th>
<th>Alternative D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Description</td>
<td>Shallow Above-Ground Reservoir</td>
<td>Deep Above-Ground Reservoir</td>
<td>Deep Below Ground Reservoir</td>
<td>Deep Below- and Above Ground Reservoir</td>
</tr>
<tr>
<td>Net Storage Volume ac. Ft.</td>
<td>1,120</td>
<td>5,510</td>
<td>6,816</td>
<td>11,979</td>
</tr>
<tr>
<td>Water Supply in mgd</td>
<td>0.0</td>
<td>2.6</td>
<td>5.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Value of Annual Benefits, estimated:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Supply to Utilities</td>
<td>$0</td>
<td>$3,091,000</td>
<td>$6,539,000</td>
<td>$11,890,000</td>
</tr>
<tr>
<td>TP Reduction to Estuaries</td>
<td>$90,000</td>
<td>$192,000</td>
<td>$382,000</td>
<td>$563,000</td>
</tr>
<tr>
<td>Reduced Discharge to Estuaries</td>
<td>$3,360,000</td>
<td>$6,537,000</td>
<td>$7,320,000</td>
<td>$9,610,000</td>
</tr>
<tr>
<td>Total Value of Benefits</td>
<td>$3,450,000</td>
<td>$9,820,000</td>
<td>$14,241,000</td>
<td>$22,063,000</td>
</tr>
<tr>
<td>Total Annualized Capital, Admin, R&amp;R and O&amp;M Cost</td>
<td>$2,285,000</td>
<td>$4,333,000</td>
<td>$3,810,000</td>
<td>$5,430,000</td>
</tr>
<tr>
<td>Annual Net Benefits (B – C)</td>
<td>$1,165,000</td>
<td>$5,487,000</td>
<td>$10,431,000</td>
<td>$16,633,000</td>
</tr>
<tr>
<td>Project Economically Feasible?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>