Sustainable water futures: integrated supply demand planning

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Introduction
Presentation overview

- Integrated resource planning (supply demand planning)
- Example: Sydney, Australia
- Examples: Alexandria, Egypt
- Example: Salalah, Oman
- The future of water infrastructure
Urban water supply-demand planning

- Detailed demand forecast
- Long-term supply estimate
- Consideration of the full range of supply & demand options
  - Large-scale source of supply
  - Demand management & decentralised supply (stormwater, reuse)
- Assessment of supply & demand options on an equal basis
- Develop a plan to balance supply & demand taking account of costs, uncertainties, sustainability impacts & other policy goals
Integrated Supply-Demand Planning Model
Sydney water demand
Germany water demand

Schleich and Hillenbrand, Fraunhofer Institute, 2007
Stock models - toilets
Stock models - *toilets*

**Water flow associated with toilet flushing**
Example supply curve - relative unit cost of options
## Typical costs - Perth

<table>
<thead>
<tr>
<th>Source or option</th>
<th>Yield (GL/year)</th>
<th>Capital cost ($m)</th>
<th>Operating cost ($m/a)</th>
<th>Unit cost (¢/kL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical water efficiency options</td>
<td>30-50</td>
<td>80-100</td>
<td>2-5</td>
<td>15-40</td>
</tr>
<tr>
<td>Eglinton groundwater</td>
<td>17</td>
<td>47</td>
<td>3.2</td>
<td>37</td>
</tr>
<tr>
<td>Wellington Dam (no treatment)</td>
<td>15</td>
<td>25</td>
<td>3.8</td>
<td>36</td>
</tr>
<tr>
<td>Wellington Dam (with treatment)</td>
<td>15</td>
<td>55</td>
<td>6.2</td>
<td>66</td>
</tr>
<tr>
<td>Southern Perth Basin Stage 1</td>
<td>41</td>
<td>325</td>
<td>7.7</td>
<td>71</td>
</tr>
<tr>
<td>Gingin groundwater option</td>
<td>60</td>
<td>300</td>
<td>24</td>
<td>73</td>
</tr>
<tr>
<td>Kwinana Waterlink Reuse</td>
<td>5</td>
<td>20</td>
<td>2.5</td>
<td>100</td>
</tr>
<tr>
<td>Desalination</td>
<td>30</td>
<td>205</td>
<td>20</td>
<td>112</td>
</tr>
</tbody>
</table>
Case study: Sydney
Supply demand balance - Sydney

- Available Supply
- Reduced available supply with potential Warragamba environmental flows
- Base case demand
- Drought restricted demand

Legend:
- WELS/Appliance standards
- BASIX
- Recycling
- Pressure and Leakage Reduction
- Non-residential sector
- Outdoor Residential
- Indoor Residential

Graph summary:
- Total Supply / Demand (GL/a)
- Year End June

References:
http://www.urbanwaterirp.net.au/
Relative contribution to supply and demand

- **Water savings**: 145 billion litres per year
  - 33% Leakage reduction
  - 38% Non residential
  - 24% Residential outdoor
  - 12% Residential indoor
  - 23% BASIX (efficiencies in new homes)
  - 15% Appliance standards and labelling

- **Recycling**: 70 billion litres per year
  - 15% Existing projects
  - 15% Projects under construction
  - 27% Western Sydney Recycled Water Initiative
  - 6% Camella
  - 7% Local projects

- **Additional supply**: 77 billion litres per year
  - 40% Deep water
  - 7% Groundwater readiness**
  - 30% Desalination readiness*
Real options analysis

SCA Total System Storage Depletion
Case 2
(Repetition of 24 Months inflows (1/8/03 to 31/7/05))

- Actual Storage as at 22/8/05
- Base Case 2
- 2a) 125ML/d Desal from 12/08
- 2b) 500ML/d Desal From 12/08
- 2c) Accelerated Demand Management
- 2d) Accelerated Demand Management + 125ML/d Desal from 12/08
- 2e) Accelerated Demand Management + 500ML/d Desal from 12/08
- 10% Storage
- Minimum Operating Level of SCA Dams

- Avon Deep Storage Accessed Jan 2010
Case study: Alexandria

Integrated supply-demand planning for Alexandria, Egypt, 2011
Figure 8: Projected water demand in Alexandria to 2037 with water savings from a portfolio of demand management and supply options – Scenario 1.
Figure 10  Supply curve for options in scenario 1
Case study: Salalah
Cumulative savings/ supply and cumulative cost

[Diagram showing cumulative present value cost (PV M RO) versus water saved or supplied in 2020 (Mm3/a) with labels for UDM8, ADM11, UDM7, ADM16, ADM14, ADM18, UDM5, ADM13, UDM6, ADM12 & 15, ADM9, ADM19, S26, UDM3, S24, S23, UDM4, ADM20 & UDM1, ADM10, ADM21, UDM2, S30, S28, S32, S22.]
Groundwater modelling results
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Impact of large scale augmentation

Energy Intensity (kWh/kL)

- Inter-basin transfer - Shoalhaven
- Desalination plant
- Inter-basin transfer – Murray River

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Energy Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000/01</td>
<td>Sydney</td>
<td>0.2</td>
</tr>
<tr>
<td>2006/07</td>
<td>Sydney</td>
<td>1.8</td>
</tr>
<tr>
<td>2001/02</td>
<td>Perth</td>
<td>0.4</td>
</tr>
<tr>
<td>2006/07</td>
<td>Perth</td>
<td>1.2</td>
</tr>
<tr>
<td>2005/06</td>
<td>Adelaide</td>
<td>0.8</td>
</tr>
<tr>
<td>2006/07</td>
<td>Adelaide</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Four generations of water infrastructure

1. Unmanaged
2. Centralised
3. Transitional (neo-centralised)
4. Emerging … (Efficient, decentralised), integrated, fit-for-purpose
The economics of generational change

Relative cost per household

First

Second

Third

Fourth

Generations

We are here
ONE CENTRAL PARK
623 apartments
5 level retail/lifestyle centre
Cantilever and heliostat

Ateliers Jean Nouvel/PTW Architects
Lighting by Yann Kersale
Living walls by Patrick Blanc
Most manure was recycled; Human waste recycled in China; No such thing as synthetic or processed fertilizer.

Repeated famines and soil degradation in Europe triggered use of other sources of fertilizers (guano, ground bone).

Discovery of phosphate rock.

Rapid population growth, urbanisation, intensive agriculture and the Green Revolution => increase in fertilizer production. Recycling organic nutrients dramatically decreases.
Looking to the future…

- Widespread application of Integrated Resource Planning
- ‘Fourth Generation’ distributed water infrastructure
- Best practice drought response strategies – ‘real options’
- Recognition of water-energy nexus
- Smart metering, with Smart Feedback
- Nutrient recovery
- Community engagement in decision-making